# Annual Report for 1953

## LAKE STATES FOREST EXPERIMENT STATION

M. B. DICKERMAN – DIRECTOR

U.S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
ST. PAUL, MINNESOTA

The Lake States Forest Experiment Station is located on the St. Paul Campus of the University of Minnesota. It is a regional branch of the United States Forest Service and is maintained in cooperation with the University of Minnesota. Through federal legislation, it is authorized to carry on forest research for the benefit of all forestry agencies in the region, including public forest services, wood-using industries, farmers, and other forest users.

The territory in which the Station operates includes the States of Michigan, Wisconsin, Minnesota, and North Dakota. In addition to the central office in St. Paul, field offices are located at East Lansing and Marquette, Michigan; Rhinelander, Wisconsin; and Grand Rapids, Minnesota.

# 30TH ANNIVERSARY REPORT OF THE

# LAKE STATES FOREST EXPERIMENT STATION

## For the Calendar Year 1953

Lake States Forest Experiment Station
St. Paul Campus, University of Minnesota
St. Paul 1, Minnesota

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# LAKE STATES FOREST EXPERIMENT STATION

## ANNUAL REPORT FOR 1953

### FOREWORD

Nineteen hundred and fifty-three was an eventful year in forestry in the Lake States. In this year three forest schools—Michigan State College, the University of Minnesota, and the University of Michigan—marked their fiftieth anniversaries. Too, it was the thirtieth anniversary of the Lake States Station. These anniversaries emphasize the "coming of age" of forest education and research. In the lifetime of these institutions cutting of the virgin timber of a major forest region was completed, making a tremendous contribution to the westward growth and expansion of agriculture and industry. Second-growth forests are now developing, but in their conversion to full productivity and intensive management, many problems must be overcome. The Station's research program, reviewed in the following report, is working toward solutions to these problems. Some of the more significant happenings relating to Station activities in 1953 are given brief mention.

Emphasis in the Station's program in 1953, as it was 30 years ago, continued to be on cooperative research efforts and projects. Two more cooperative agreements were signed in Minnesota for the financing of forest management studies. Some 53 companies and public agencies are now cooperating with the Station on specific research projects. Cooperation in helping to guide the Station's program was obtained through advisory committee meetings held at each research center to solicit comments on future research needs and plans.

Serving in the capacity of a regional research coordinator and leader, the Lake States Station, in cooperation with others, during 1953 sponsored regional meetings on forest genetics and on the use of chemical controls in forest management. These meetings, attended by about 150 technical personnel, resulted in comprehensive reports which were assembled and published by the Station, thereby disseminating the most recent information on two timely subjects.

In Upper Michigan the Station's experimental forest, along with several other timber tracts, suffered a serious loss from a severe windstorm. On the experimental forest over one-half million feet of old-growth, high-value timber were blown down; necessary salvage operations were completed this fall. Two long-term methods of cutting studies were partially destroyed, resulting in a serious disruption to management studies in northern hardwoods.

Toward the end of the year, through reorganization in the Department of Agriculture, two major research programs on forest insects and forest diseases were transferred to the Station. This transfer will have no

adverse effect on insect and disease work already underway and should result in the future development of a more effective and coordinated forest research program.

A renewed interest in the potentially productive swamp forests of the region was evidenced by new work in the black spruce (Big Falls) experimental forest in northern Minnesota, by arrangements for more cuttings in the cooperative swamp forest management project in the Upper Peninsula of Michigan, and the finding that aerial spraying of a brushy swamp made possible the successful planting of black spruce.

These, in brief, are the more significant events of 1953 relating to Station activities. The following pages discuss briefly fields in which progress has been made in the last 30 years and indicate the problems and needs for a broadening program in the future. A detailed summary of active projects and plans for 1954 is presented as a progress report starting on page 5. Station publications issued in 1953 are listed on page 39.

## THIRTY YEARS OF PROGRESS IN FOREST RESEARCH

In 1923 when the Station got underway, conditions differed greatly from those of today. There were only three national forests in the Lake States then; today there are seven covering 6.2 million acres. County forests were virtually nonexistent, today they include 6.9 million acres. States controlled large acreages but had very little forest land under management. Today there are 56 state forests, covering 8.9 million acres under management. Industrial foresters were almost unknown in the region, but today most of the major wood-using companies have forestry staffs, and many are practicing forestry on their holdings.

Thirty years ago, most of the pine sawtimber had been cut, but hardwood lumber production was still booming. Pulpmills were expanding, but even in 1923 supplies of spruce were dwindling. Memories of the big Cloquet fire in Minnesota were still vivid. Aspen and jack pine were coming in on large areas, but industry was not geared to the use of these smaller trees. Large areas were not restocking satisfactorily.

Recognizing these conditions, the Station's program early developed along four major lines: (1) forest-management studies of the reproduction, culture, and harvest of the major forest types, including the planting of trees for timber production and for shelterbelts; (2) analysis of the complex fire problems and the development of remedial methods, (3) a survey and analysis of the timber resource situation, (4) studies of the effects of land use on soil erosion and streamflow. The first three fields have constituted the bulk of the Station's program for nearly 30 years. Today there is a good supply of technical information for practicing foresters on each of these subjects.

In forest management, studies have been made for most major tree species and forest types. There are now general guides for obtaining natural reproduction and planting, for cultural practices to improve the quality and value of growth, for stand-improvement work to increase future yields and for various other jobs in the culture of timber growing. Completion of studies already under way will further refine practices now in use.

Recommended forest management practices for the red pine, jack pine, black spruce and northern hardwood types, have been presented in summary publications. A series of reports on aspen use and culture provide similar information for that type. Numerous investigations in these and other timber types have made available additional information about seed sources, stand improvement, pruning, and other measures for increasing the volume and raising the quality of forest production. A comprehensive guide to the planting of conifers has been distributed. With the cooperation of other Stations, a basic seed manual of national scope was prepared. Current management based on this fund of knowledge is far more intensive than that of 30 years ago, and this trend will continue as the results come in from work now in progress.

In fire control, startling advances have been made by the teamwork of administrative and research personnel. In the twenties, each year there were some 10,000 forest fires and 1 million acres of forest burned in the Lake States. In the fifties, the annual average is 4,000 fires and not over 100,000 acres burned. Through the analysis of detection needs, by providing information for effective planning, by understanding conditions relating to fire occurrence and behavior and by developing hazard ratings and inflammability guides, a highly effective system of fire protection now exists in the Lake States.

In timber-resource studies, the Station started back in the early thirties making county inventories and analyses of growth and drain. By 1945 the entire region had been inventoried. The first comprehensive report summarizing the timber resources of the Lake States was published in bulletin form in 1950. The Station, working cooperatively with the states and industry, is now concentrating on a survey of the changing timber supply situation.

Pioneering forest influences studies, which had to be curtailed some years ago, indicated the seriousness of soil erosion losses along tributaries of the Upper Mississippi River, some practical means of gully control, the effectiveness of different land uses in reducing run-off in the driftless area, and the influence of windbreaks on wind velocity and related factors.

That marked changes have been taking place in the forest economy of the Lake States is clearly evident. Practically all of the old-growth timber has now been cut. Second-growth is coming along, rapidly in some places, slowly in others. Because of the failure to get reproduction in the course of transition, some 25 percent of the forest land is poorly stocked or deforested, thereby pointing to a most serious problem relating to the productivity of land.

Industrial timber needs are changing too, mostly on the side of increasing needs. In the last 30 years pulpwood consumption in the region has gone up from 1.5 to 3.2 million cords, veneer log consumption is up from 57 to 78 million board-feet. Lumber production has dropped from 2.5 to 1.0 billion board-feet and the number of distillation plants has dropped from 16 to 3. In lumber, the region is supplying less than half of its current consumption.

Forest research is helping to strengthen the regional forest economy but to be of maximum service a greater effort is needed. In forest management, presence of the potentially productive oak type should stimulate more work in the southern part of the region. In the other timber types cultural methods for stimulating natural reproduction need refinement so that the high cost of planting can be avoided. Greater emphasis needs to be placed on methods for attaining adequate stocking at minimum cost on cut-over lands and on other areas which are now poorly stocked.

Reduction of losses from diseases, insects, and wildlife species will aid in maintaining proper stocking. Greater knowledge in these fields is necessary not only for the protection of established stands but also to keep reproduction once it is obtained.

Forest genetics is almost a virgin field in the Lake States. Studies of seed source, breeding for resistance to disease, the selection of superior stands and trees as seed sources, and breeding for vigor and rapid growth combined with good wood quality all hold promise for the future. But the Station's program is now seriously lacking in such work.

Forest influences research is a neglected field. Neither the Station nor others working in research have been able to give adequate attention to the relation of forests to water. Industry and population gains in the Great Lakes area have been rapid and each increase necessitates the use of more water. So far, we know only in a general way the relation of forests to water--its quality and quantity. Before long, work needs to be initiated in this field.

Utilization is changing too, and so are the needs for utilization research. Year-round logging as a means of stabilizing forest management, employment, and equipment use is a matter of urgency. Some companies are already trying more summer logging. But problems

such as the need for developing new types of logging equipment, new logging methods, and labor efficiency are involved. The neglect of this field will have a telling effect on the competitive position of the Lake States in the national market unless research is started soon. The Station's part in this work should be as in all other major regions—serving as a liaison between industry, public agencies, and the Forest Products Laboratory and other research units.

## FOREST PROTECTION

Today, as it was 30 years ago, forest protection is of prime importance. Unless there is reasonable assurance that stands can be brought through to harvest age, there is little incentive for management. Thirty years ago fire protection was the most urgent problem. However, fire protection increased and has improved so that today the forests of the Lake States are damaged more, year in and year out, by insects, diseases, and wildlife than by fire. The Station has conducted some research in fire protection and wildlife for many years. Reorganization of the Department of Agriculture has now added forest disease and forest insect research to the Station's program. This will permit a unified attack on forest protection problems in the region.

### Forest Diseases

During 1953, forest disease research at the Station was directed mainly toward studies of (1) factors influencing the incidence of Hypoxylon canker in aspen stands, (2) the occurrence of defect in northern hardwoods, (3) the determination of whether or not there are races of white pine blister rust, (4) a root rot problem of white pine at the Chittenden Nursery, Wellston, Michigan, and (5) a twig injury of red pine.

Factors Influencing the Incidence of Hypoxylon Canker of Aspen.

This study, started five years ago, has progressed largely because of the extensive and active participation of the pulp and paper industry in the Lake States. Results obtained from survey plots, established during the initial phase of the study, indicated that tree vigor and site quality did not influence incidence of the disease. The results obtained did indicate that stand density and exposure of tree stems may be important factors. Further studies of the influence of stand density were started in 1952 and expanded in 1953.

Aside from these activities the principal product of 1953's work was emphasis on the fact that less is known about Hypoxylon canker than was previously supposed. It was believed earlier that Hypoxylon was a simple wound parasite; i.e. if there were a wound in aspen bark there would be a good chance that the Hypoxylon canker fungus would enter it and cause a canker to form. Attempts made to cause artificial infection were unsuccessful, indicating that the situation is more complex than formerly was supposed.

During 1954 research will proceed along three principal lines: (1) Thinning and other studies regarding the influence of stand density on Hypoxylon canker incidence will be continued. (2) Permanent plots will be re-examined to provide more accurate information on mortality rate and effect on growth, and to search for previously undetected evidence of factors influencing incidence of infection. (3) Research to provide information regarding the manner in which trees become infected will be expanded. This is information badly needed as a basis for any further work in developing control measures.

Races of White Pine Blister Rust.

Many fungi are able to develop new races, or varieties, which differ in their abilities to infect plants. Or, a new race of a fungus may be introduced from a foreign area. In either case plants formerly considered resistant may be attacked by a new race or variety of a fungus. At the present time, considerable interest and effort are being directed toward developing varieties of white pine that are resistant to blister rust infection. For this reason, a study was initiated three years ago to determine (1) whether or not the white pine blister rust fungus is composed of a number of races, or varieties differing in their ability to infect white pines, and (2) what the likelihood is of new and more virulent races developing that might infect previously resistant varieties of white pine that have been developed. During 1953 some evidence was found that would seem to indicate that there is more than one race of the fungus. This difference was noted on Ribes, the alternate host, and cannot be considered proof that such differences occur on the white pines.

The white pine blister rust race study will be continued in 1954 to determine whether such differences as have been observed on Ribes actually are attributable to more than one race of the fungus, and make similar studies on the white pine hosts.

White Pine Root Rot.

The white pine root rot problem at the Chittenden Nursery in Michigan has received attention in recent years. Various fungicides, insecticides, and fumigants have been tested and have given inconclusive results. As yet it has not been determined whether the root rot is brought about by disease causing organism or the physical environment.

During 1954 the white pine root rot study will be continued with special emphasis on determining whether or not a disease causing organism is involved.

Red Pine Twig Injury.

Observations have been made for a number of years on a twig injury of young red pine. Prior to 1953 this kind of injury had been noted only in Michigan and Wisconsin plantations. During 1953 damage was observed on natural reproduction in the Cloquet and Cut-foot Sioux areas of Minnesota. The cause of this injury is as yet unknown.

The red pine twig injury problem will be kept under observation in 1954. Attempts will be made to determine whether a single disease or a number of different but similar diseases cause the damage.

Other Plans for 1954.

Other plans for 1954 are (1) to continue the study of defect in northern hardwoods, so far limited to hard maple, so as to include other northern hardwood species, particularly yellow birch, and (2) to set up experiments to determine the most feasible and practical method of controlling black spruce dwarf mistletoe infections. This disease causes serious damage to black spruce and available knowledge indicates that practical control measures can be prescribed.

## Forest Insect Research and Surveys

Forest insect pests are an important source of injury to Lake States Forests. Discovering trouble spots and developing control methods are the major functions of this division. Research and surveys in 1953 were directed against several species of pine sawflies, the larch sawfly, the jack-pine budworm, the Saratoga spittlebug, the European pine shoot moth, and the walkingstick.

Pine Sawflies.

Increasing populations of the various pine sawflies in 1952 indicated the need for more research. A conference, attended by representatives from various agencies in the United States and Canada was held at Urbana, Illinois in March 1953 to develop the major needs and objectives for such a research effort. This Station was requested to carry out studies to the limit of its facilities on (a) biological and ecological factors to facilitate separation of the several closely related species, (b) studies of management practices designed to prevent or at least minimize defoliation injury, and (c) evaluation of survey techniques. Preliminary studies were begun on the Hoosier National Forest, Indiana, in April 1953 and on the Lower Michigan National Forest in June 1953. Detection surveys by state and federal agencies indicated an increase over the 1952 populations, with heavy "spot" infestations of small acreages well distributed over the entire region. Examination of red pine plantations at the Henderson State Forest, Illinois, infested with the European pine sawfly and treated with a virus disease, showed that the virus had survived and had dispersed to a limited degree through the succeeding generation and outside of the spray area.

In 1954 research on the biology, ecology, and control through parasites and predators, diseases, and insecticides will be expanded. Because experimental virus spray treatments against the European pine sawfly in Illinois proved highly successful and the virus had survived through the succeeding generation an airplane control project has been recommended to the State Forestry Division.

Larch Sawfly.

Additional research on the larch sawfly in Minnesota showed that tamarack trees will react to repeated heavy feeding by putting out fewer and shorter new shoots, and somewhat later than under normal growth conditions. Under these conditions complete defoliation did not occur. Tree mortality, directly attributable to this insect has not been noted. Parasites, as a control factor, have been of minor importance chiefly because of the ability of the host insect to encapsulate the egg of its principal parasite. Aerial and ground surveys showed that approximately 450,000 acres of the 675,000 of tamarack type in Minnesota suffered partial to complete defoliation. The aerial survey was a 16.7-percent cruise, based on strips 2 miles wide along flight lines 12 miles apart. Approximately 15,000,000 acres of land area were flown at a cost of approximately 8 cents per thousand acres.

During 1954 the biological and ecological studies of the larch sawfly will be continued to check the findings of the research for the two previous seasons. Growth studies in tamarack stands should be initiated to determine the effects of repeated defoliation. The effectiveness of the newer insecticides should be tested against this insect under laboratory conditions. The aerial survey should be continued.

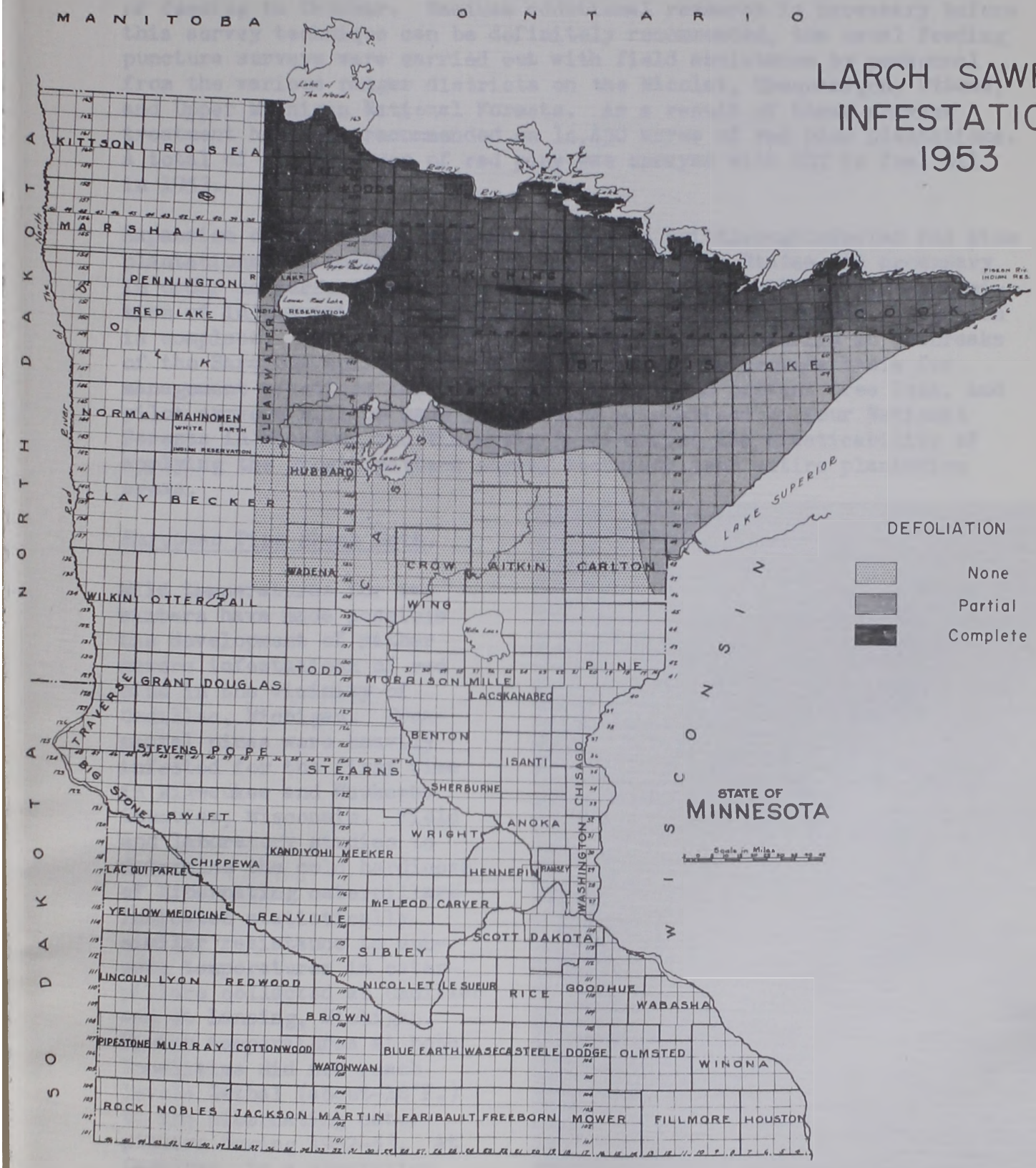
Jack-Pine Budworm.

Periodic collections of caterpillars, pupae, and eggs of the jack-pine budworm, for the past 3 years, in lower Michigan and in 1953 in upper Michigan, were made to determine the effect of natural control factors. Sixteen species of parasites were recovered from the lower Michigan collections; preliminary dissection of material from upper Michigan indicated a small but significant parasitization by a species not previously reported from jack pine in the Lake States or adjacent Canada. The infestation in lower Michigan declined in severity in 1953 and surveys on the Huron National Forest indicated no significant additional mortality of jack pine. Approximately 10,000 acres of high grade merchantable jack pine, on the Lake Superior State Forest, upper Michigan, were heavily defoliated and it is believed a moderate infestation exists over a much larger adjacent acreage. About 1,000 acres on the Raco ranger district, Upper Michigan National Forest, were also heavily infested. A moderate infestation was reported on 1,000 acres of jack pine in northwestern Wisconsin.

In 1954 investigations of the natural control factors of the jack-pine budworm will be continued in the jack pine types in Michigan and should be begun in Minnesota and Wisconsin.

Saratoga Spittlebug.

Studies initiated in 1951 revealed that feeding injury to red pine by this spittle insect could be measured before actual twig-killing (flagging) became evident. During 1953 investigations were conducted


MANITOBA
ONTARIO
LARCH SAWFLY
INFESTATION
1953
KITTSON
ROSEAU
MARSHALL
PENNINGTON
RED LAKE
NORMAN
MAHNOMEN
WHITE EARTH
INDIAN RESERVATION
CLAY
BECKER
HUBBARD
WADENA
CROW WING
AITKIN
CARLTON
WILKIN
OTTER TAIL
GRANT
DOUGLAS
TODD
MORRISON
MILLE LACS
KANABEC
PINE
TRAVERSE
BIG STONE
STEVENS
POPE
STEARNS
BENTON
ISANTI
CHISAGO
SHERBURNE
SWIFT
WRIGHT
ANOKA
WASHINGTON
KANDIYOHI
MEEKER
CHIPPEWA
LAC QUI PARLE
HENNEPIN
RAMSEY
YELLOW MEDICINE
RENVILLE
McLEOD
CARVER
SCOTT
DAKOTA
SIBLEY
LINCOLN
LYON
REDWOOD
NICOLLET
LE SUEUR
RICE
GOODHUE
WABASHA
BROWN
PIPESTONE
MURRAY
COTTONWOOD
WATONWAN
BLUE EARTH
WASECA
STEELE
DODGE
OLMSTED
WINONA
ROCK
NOBLES
JACKSON
MARTIN
FARIBAULT
FREEBORN
MOWER
FILLMORE
HOUSTON
LAKE SUPERIOR
ST. LOUIS
LAKE
COOK
LAKE OF THE WOODS
RED LAKE
LOWER RED LAKE
LOWER RED LAKE INDIAN RESERVATION
PIGEON RIV. INDIAN RES.
NORTH DAKOTA
SOUTH DAKOTA
WISCONSIN
STATE OF
MINNESOTA
Scale in Miles
DEFOLIATION
None
Partial
Complete

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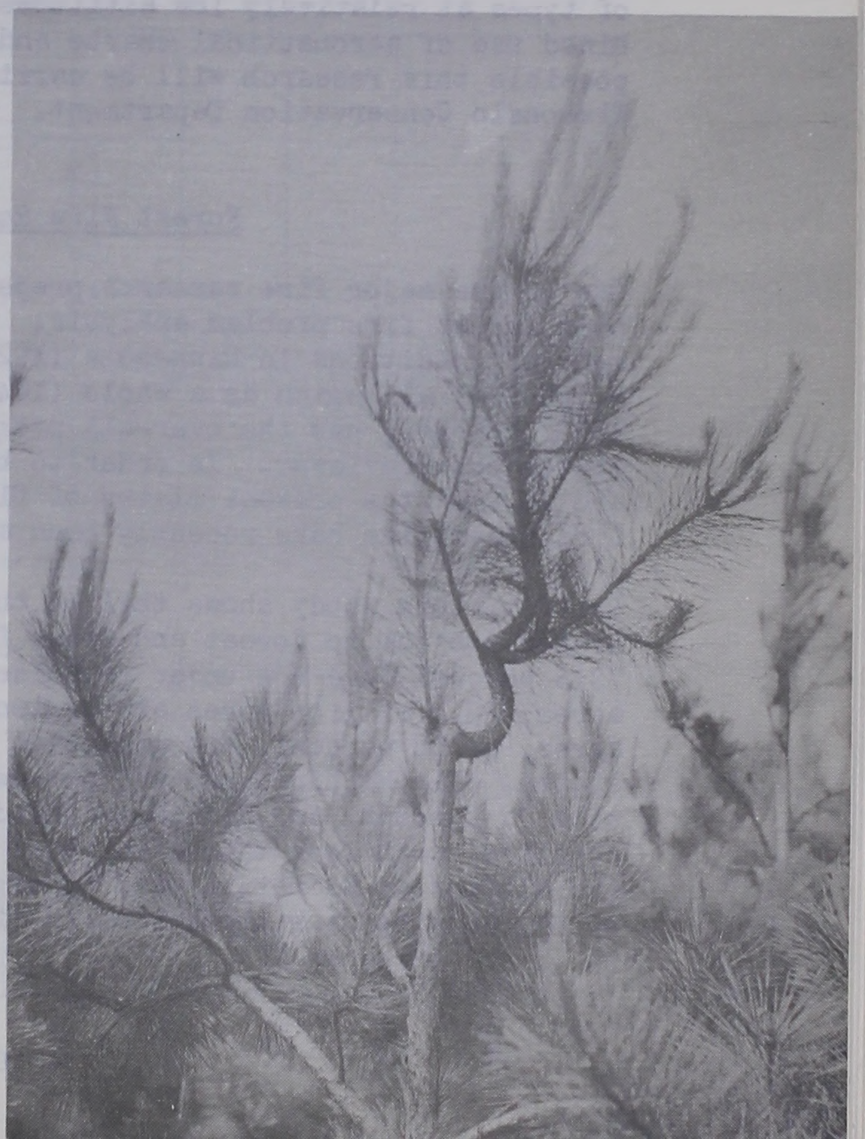
to determine the possibility of detecting this injury prior to the completion of terminal and lateral elongation. Analysis of these growth studies indicates that these measurements can be made during July and August, instead of during a brief 2-week period following cessation of feeding in October. Because additional research is necessary before this survey technique can be definitely recommended, the usual feeding puncture surveys were carried out with field assistance by personnel from the various ranger districts on the Nicolet, Chequamegon, Ottawa, and Upper Michigan National Forests. As a result of these surveys treatment has been recommended on 14,450 acres of red pine plantations. A total of 11,280 acres of red pine was sprayed with DDT in fuel oil in 1953.

Expansion of the growth pattern studies in spittlebug-infested red pine plantations, to include all sections of the Lake States, is necessary in order to perfect new survey techniques. These will permit recognition of injury prior to "flagging" and before annual growth elongation is complete. During 1954 studies of conditions conducive to outbreaks of the Saratoga spittlebug will be undertaken to provide basis for management practices that will limit attack and prevent tree loss, and pilot surveys will be made in red pine plantations on four National Forests in Michigan and Wisconsin to determine the practicability of applying the growth pattern survey technique over entire plantation areas.



European Pine Shoot Moth.

Mild temperatures for two winters have made possible the development of rather severe infestations of red pine in the vicinity of Cadillac, Michigan. Ornamental pines were heavily infested for the first time in Milwaukee and Waukesha Counties, Wisconsin. Field and laboratory studies to determine the cold hardiness of hibernating caterpillars indicated statistically similar resistance to subzero temperatures in caterpillars collected at Cadillac and at Lansing, Michigan. Winter temperatures at both localities did not reach levels lethal (about -18°F.) to the hibernating caterpillars during 1952-53. At Cadillac, in a plantation under observation the cater-

pillars survived in infested buds at all levels up to 9 feet above ground.

Additional red pines were selected at Cadillac in the fall of 1953 and infested buds were tagged at 1-foot levels to determine winter mortality. These trees will be examined in April, 1954.

Walkingstick.

Surveys on the Menominee Indian Reservation in Wisconsin showed moderate to heavy defoliation of oak and basswood on approximately 1,200 acres by the "off-year" brood of the walkingstick. Egg surveys in October showed as high as 130 eggs per square foot of duff. These eggs will carry over until 1955 when heavy defoliation can be expected, and possibly over a much larger acreage.

Additional egg surveys will be made in the early fall of 1954 to determine the acreage needing control treatments in 1955.

Research in Aerial Surveys.

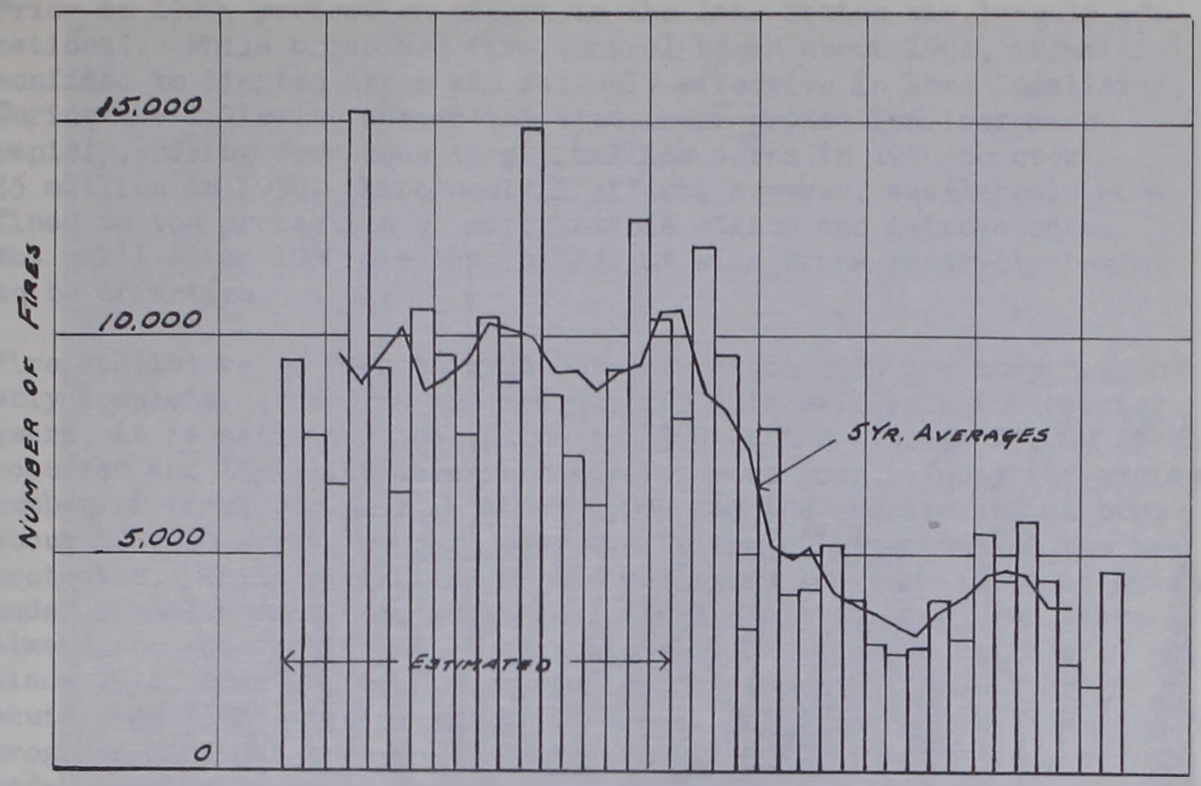
During 1954 research will be made concerning effects on surveys of height of flight above the relatively level terrain of the jack pine, tamarack, and aspen types in the northern Lake States and of definition of types at relatively low altitudes. Tests will be made of the combined use of aeronautical charts and an operation recorder. It is possible this research will be carried out in cooperation with the Wisconsin Conservation Department.

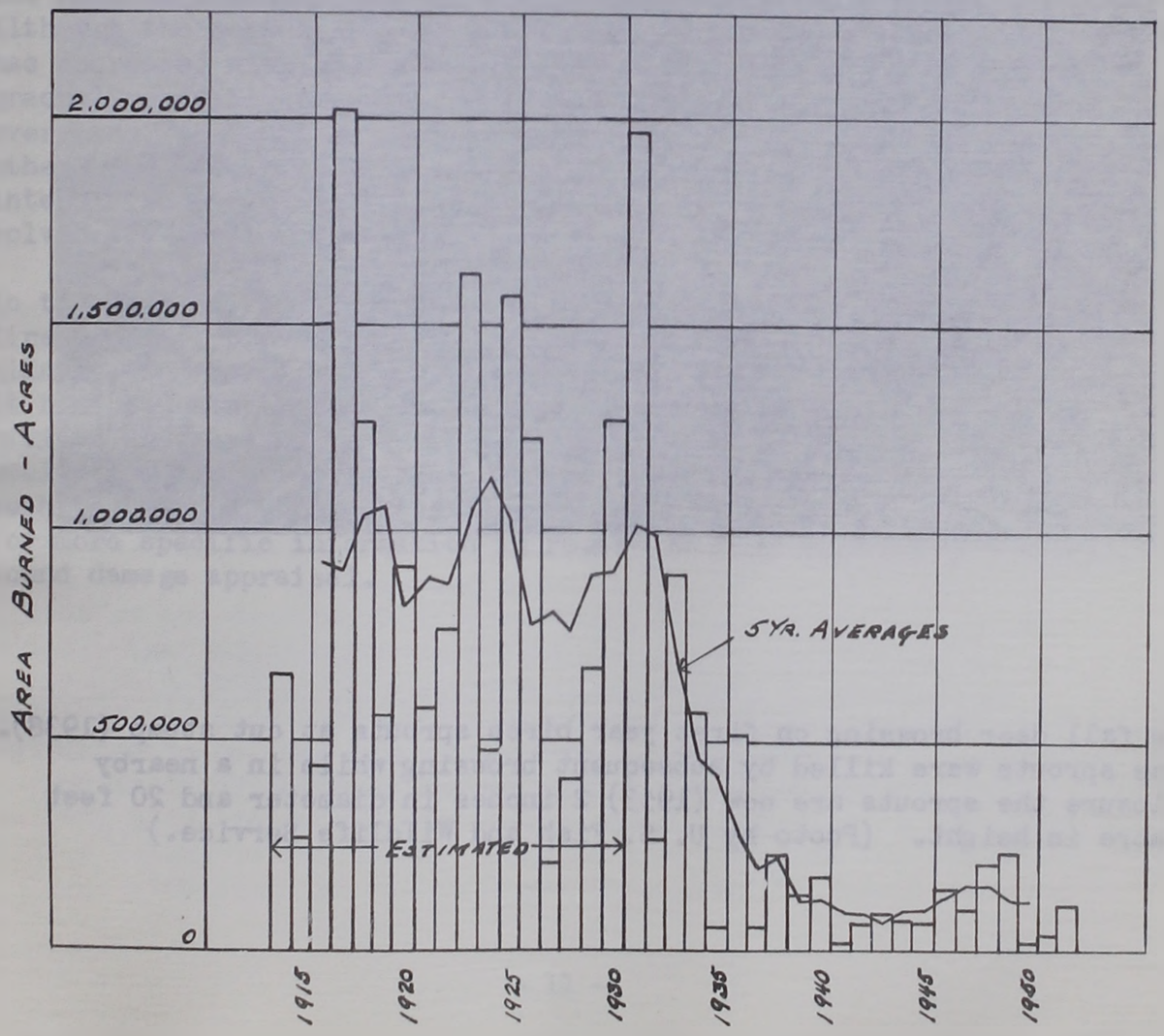
## Forest Fire Research

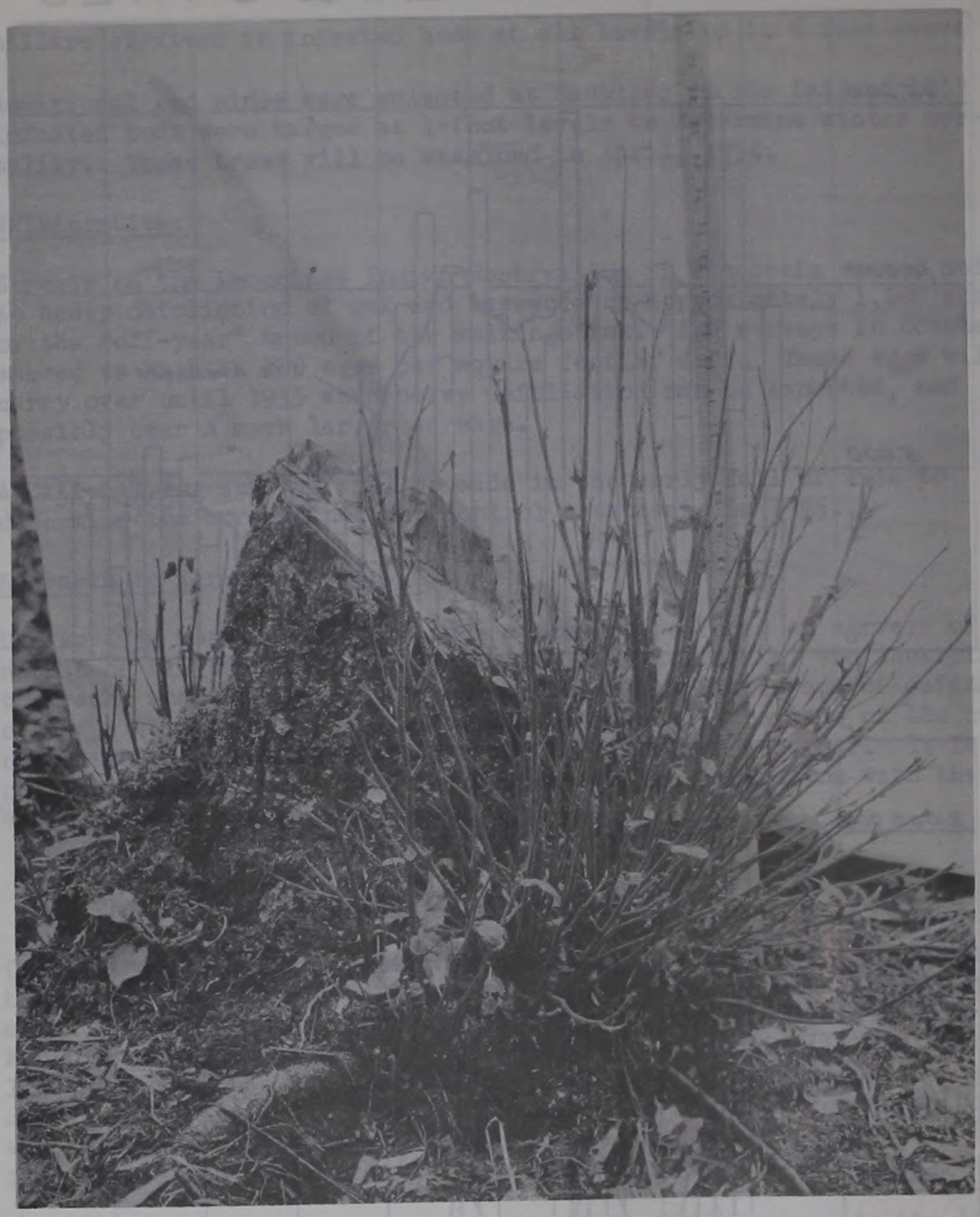
One of the major fire research projects at the Lake States Station has been forest fire problem analysis. In the past, studies have been made of conditions in Minnesota (1927), Michigan (1931 and 1950), the North Central Region as a whole (1940), and Wisconsin (1952). Not since 1938, however, has the over-all progress in fire control in the Lake States been reviewed. In order to bring the regional record up to date and to show the present status of fire-control effort, available forest fire statistics have recently been assembled and are being analyzed.

Briefly, this study shows that of the 74.8 million acres in the Lake States subject to forest and grass fires some 58.8 million acres, or 78.5 percent, are now under organized protection. Of this 58.8 million acres, 48.2 million acres are protected by the states and 10.6 million acres, or 18 percent, are protected by the Federal Government. Of the states, only Michigan has 100 percent coverage, Minnesota is second with 77 percent, and Wisconsin third with 56 percent. If agricultural counties, with less than a third of their area subject to wild fires, are eliminated as not in need of organized protection, the percentage of the area needing protection in Minnesota is 90 and in Wisconsin 60.

# FOREST FIRES - LAKE STATES





Late fall deer browsing on first year birch sprouts at cut stump (1938). These sprouts were killed by subsequent browsing while in a nearby enclosure the sprouts are now (1953) 2 inches in diameter and 20 feet or more in height. (Photo by U. S. Fish and Wildlife Service.)

Prior to 1920, protection effort in the Lake States was largely educational. While organized fire control began about 1904, it was confined to limited areas and was only effective in some localities. During the following decade the area under protection increased rapidly, rising from less than 5 million acres in 1920 to over 55 million in 1930. Fire-control effort, however, was largely confined to the protection of merchantable stands and improvements. Not until after 1930 did the control of wild fires generally begin to be effective.

Fire statistics go back to 1914 but only since 1930 are they reasonably complete. Based on the fragmentary data available for earlier years, it is estimated that prior to 1930 on the average 10,000 fires occurred and 1 million acres burned over each year. Today the average number of fires per year is about 4,000 and the average annual burn about 125,000 acres, or just over two-tenths of 1 percent of the area protected. While protection on the whole may now be said to be adequate under normal conditions, occasional fires still get away and there is always the possibility of an exceptionally bad year to be faced. Not since 1918, however, has there been a catastrophic fire, although acute conditions have prevailed at times. Chiefly responsible for the progress made has been the prompt control of fires as they occurred, made possible by more adequate appropriations, better organization, and more effective control measures and equipment. Public recognition of the potential danger of forest fires has also been a contributing factor. Although the possibility of disastrous fires remains, their probability has decreased with the disappearance of extensive slash areas and the gradual reestablishment of forest cover on much of the cut- and burned-over land, as a result of increasingly effective fire control. On the other hand, the risk or chance of fires starting has increased, due to intensified use of wild-land areas, and the destructable values involved are greater than ever before.

In the past, fire research has been primarily devoted to defining the fire problem, providing basic information needed for sound fire-control planning and developing the technique of fire control. More recently it has been concerned with the rating of hazard, risk, and inflammability, and ways and means of determining the normal fire load and evaluating the effectiveness of fire-control effort. There remains much to be done along these lines, but the greatest need at present is for more specific information in regard to fire effects as a basis for sound damage appraisal.

## Forest Wildlife Research[1/]

During 1953, forest wildlife research was directed mainly toward (1) an appraisal of range recovery in exclosures for big game and snowshoe hares, (2) an evaluation of the effect of cutting mountain maple on the production of deer browse, (3) a study measuring the effect of controlled deer hunting on range recovery, and on the weight, sex ratio, productivity, and age composition of the deer herd on the Tamarac National Wildlife Refuge, (4) a study of the effects of several methods of cutting mixed coniferous swamps in obtaining tree reproduction and shrubs of value to deer and other wildlife, and (5) a study of birds and mammals in relation to the establishment of tree seedlings and other woody plants following fire in a mixed conifer type.

### Effect of Hare Damage on Forest Plantations.

Hare damage to planted jack pine seedlings has been observed in northeastern Minnesota for many years but actual measurements of such damage have not been available. In 1949, an exclosure was constructed in a jack pine plantation in which 2-0 stock had been set out in the fall of 1948 and replanted with similar stock in the fall of 1949 because of heavy hare damage. So far deer damage has been minor, but the results show hare damage was severe in 1950 and 1951—although none of the seedlings suffered mortality. Measurements indicate the greatest damage to seedlings has been loss in height. Increases in height since 1945 were as follows: 41 percent in the hareproof section of the exclosure, 24 percent in the section accessible to hares but closed to deer and 20 percent in the unprotected area. Also seedlings protected from hares produced two and a half times more growth per seedling than those accessible to hares in the deerproof section of the exclosure and in the control plot.

### Effect of Cutting Mountain Maple on the Production of Deer Browse.

In 1935 and again in 1937 investigative work on the effect of cutting shrubs and young trees to induce sprout growth was initiated in Cook County, Minnesota, on the Superior National Forest. Of all the species tested, mountain maple, a shrub of no commercial importance, produced the most browse. It also has the advantage of being a staple and highly preferred deer food of wide distribution in northern Minnesota.

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1/ Conducted by the U. S. Dept. of the Interior, Fish and Wildlife Service. The biologist is employed in the Section of Wildlife Investigations on Public Lands, Branch of Wildlife Research. Research is conducted under cooperative agreements with the Forest Service, the National Park Service, the Office of Indian Affairs and the Branch of Refuges of the Fish and Wildlife Service.

In the spring of 1937 the clumps of mountain maple on several 2-acre test plots were cut at ground level to induce sprouting. After the first growing season browse production was determined by measuring the annual growth on 50 test clumps selected at random within these plots. These test clumps were found to produce twice as much browse as the untreated clumps in the same general area. A remeasurement in 1952 of 50 test clumps also taken at random has shown that the amount of available deer browse remained high sixteen years after cutting. Only 1.8 percent of the main shoots had grown out of reach of deer (7 feet), while overbrowsing caused the death of 18 percent of them. The average number of stems per clump remained about the same but the length per stem decreased by 50 percent. Since the original measurements (1937) represent first year sprouts, the length decline in 1952 indicates the probable normal growth characteristics of the mature plant after the root system has adjusted to the smaller crown area. The nutritional quality of the browse, which is centered in the tips, remained high because the number of stems was about equal both years.

Results of Controlled Deer Hunts on the Tamarac National Wildlife Refuge.

This 62 square mile refuge in northwestern Minnesota has been open to hunting with fire arms for three years (1951-1953). Each year about half of the refuge has been open under an alternating system. Data obtained at checking stations showed that (1) During three open seasons 7,100 hunters bagged 1,587 deer for a success ratio of 22 percent; (2) Fawns made up 31 percent of the kill in 1951 and 1953 and 35 percent in 1952; (3) The number of fawns produced increased from 70 per 100 does in 1951 to 77 in 1953; (4) After three years of hunting the adult sex ratio has tended to become more even as the males increased from 53 per 100 females in 1951 to 75 in 1953; (5) Average weight data on 1,267 deer have shown the following changes: the fawns increased 13 and 14 pounds; the does first increased 4 pounds and then decreased 3 pounds; the bucks stayed the same for two years and then decreased 11 pounds; (6) During the first two seasons the percentage distribution of the kill was much alike and both showed a weakness in the $1\frac{1}{2}$ and $2\frac{1}{2}$ year age groups. The weak $1\frac{1}{2}$ year class in 1951 was also weak in 1952 and 1953. However, the weak $2\frac{1}{2}$ year class in 1951 appeared as a strong $3\frac{1}{2}$ year class in 1952 although it should have been weak. In contrast the 1953 data show strong $1\frac{1}{2}$ and $2\frac{1}{2}$ year groups and very weak $3\frac{1}{2}$ and $4\frac{1}{2}$ year classes; (7) The average age of the herd has been reduced by one-half of a year (3.3 to 2.8) and remained at that level for two years. If the refuge had been open in the fall of 1942 and about 35 percent of the deer population had been removed annually, it seems probable that about 6,000 deer could have been harvested over the 9-year period (1942-1950). This would have meant orderly hunting seasons, and about 4 times more deer for the hunters. But more important would be, the protection of the deer range from severe overbrowsing and the lowered carrying capacity resulting from such over-utilization.

## FOREST MANAGEMENT

The early sawmilling industry in the Lake States was largely dependent on red and white pines for its stumpage supplies. Naturally one of the big jobs facing the new Lake States Forest Experiment Station 30 years ago was to aid in establishing new stands of pine where the old ones had been cut. Methods for obtaining natural regeneration and for successful planting were both desired. Red pine was favored over white pine because of the threat of blister rust, and jack pine received extra attention because of its ability to survive and grow on poor sandy soils denuded by fire. The need for research in the northern hardwood type also was evident 30 years ago as results of cutting showed the need for extra measures to keep cut-over lands productive.

Summaries of management information have been issued for red pine and jack pine, and for planting of conifers in the Lake States. A similar publication for the northern hardwood type became available this year[2/].

Experience during the past 30 years has shown that the research program in forest management must furnish urgently needed guides to regeneration and culture of the timber types currently of most importance. The work in pine and northern hardwoods was begun for this purpose. At the same time the research program must be broad enough to provide a framework of studies in other types which may assume greater importance as wood utilization practices shift and as available timber supplies change in character. With commendable foresight the Station's staff devoted some attention to the aspen type at a time when aspen had little economic importance. Information about black spruce also has been made available from time to time, but the basic framework of studies in the swamp types has been installed only recently and a longer period of observation is needed before they will yield the data on growth and regeneration which will satisfy management needs.

It is evident that the past 30 years have been productive ones in the forest management field in two ways: (1) information essential to the development of a stronger forest economy in the Lake States has been issued as soon as it was gathered, and has been summarized into more usable form after a considerable body of knowledge has been developed; (2) a framework of long-term studies has been established that will continue to yield for each type the information which comes from periodic remeasurement of a growing forest. In the following sections the results of some old and some new research are combined to picture the present status of the Station's program.

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2/ U.S.D.A. Technical Bulletin No. 1076, "Partial Cuttings in Northern Hardwoods of the Lake States" by F. H. Eyre and W. M. Zillgitt, September 1953.

## Management of Natural Stands

### Northern Hardwoods.

The recent summary of management information for the northern-hardwood type is based in part on study areas in the Upper Peninsula Experimental Forest damaged by wind in the summer of 1953. Fortunately, some of the older plots were not hit so the long record of effects from early cuttings will continue to accumulate. Measurements made during the past year corroborate results observed during earlier years and thus further substantiate the conclusions already published. The comprehensive information included in the bulletin[2/] will be checked and supplemented by new studies to provide even better guides to the handling of northern hardwood stands in the future.

Disking to Increase Natural Regeneration in Understocked Stands. Regeneration in understocked stands, with considerable sod or brush cover present, can be greatly improved by exposing mineral soil with a heavy disk drawn by crawler tractor according to studies in Wisconsin. The third year count on a disking in scattered northern hardwood with admixture of balsam fir showed 28,800 seedlings per acre; 45 percent yellow birch; 15 percent red and sugar maples, and 29 percent balsam fir. Fully 75 percent of all quarter-milacre plots were stocked. The seedlings now have sufficient height to be considered fairly well established.

In another disking done in an open field parallel to and within 66 feet of a timbered border, the second year counts showed an average of 101,000 seedlings per acre, of which 97 percent were yellow birch.

Successful results are obtained only when there are an adequate number of seed-bearing trees, a reasonably good seed crop, good exposure of mineral soil, near normal rainfall, especially the first season, and adequate light for survival of the species being encouraged.

Disking generally has failed to provide for successful seedling regeneration in dense sod in the center of openings more than about 75 to 100 feet in diameter, or more than two tree heights in diameter.

Natural Reproduction in Second-Growth Hardwoods. Reproduction following strip cuttings and clear cutting made several years ago in second-growth northern hardwoods in northeastern Wisconsin on the Argonne Experimental Forest included a very large amount of white ash, yellow birch, and paper birch seedlings. Counts at the end of one year revealed about 60 thousand seedlings per acre, most of them white ash and yellow birch. The second year counts showed as much as 80 to 95 percent reduction in the stand of yellow birch and sugar maple and 50 to 60 percent less white ash. If this downward trend in stocking of desirable species continues, it may prove necessary to invest in cultural treatments to better the composition of stands.

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2/ See footnote on preceding page.

Elimination of Cull Trees from Second-Growth Stands. On the Argonne Experimental Forest in northern Wisconsin a second year follow-up of power saw girdling disclosed that about half of the trees were dead, another third were dying, and the remaining nearly 20 percent were alive and vigorous. Axe girdling had essentially the same results but was about twice as costly.

Plans for 1954. During 1954 plans are: (1) to make a cooperative study with the Wisconsin Conservation Department of measures designed to improve the timber stands and at the same time provide winter browse for deer; and (2) to begin a study of stocking levels in second-growth stands of the Upper Peninsula of Michigan.

Pine.

Although reduced considerably in acreage by logging and fires, red pine, white pine, and jack pine still are important in the economy of parts of the Lake States region. Red pine and jack pine have been extensively studied and considerable management information is available on these types. During 1953 several measurements and observations have added to this fund of knowledge.

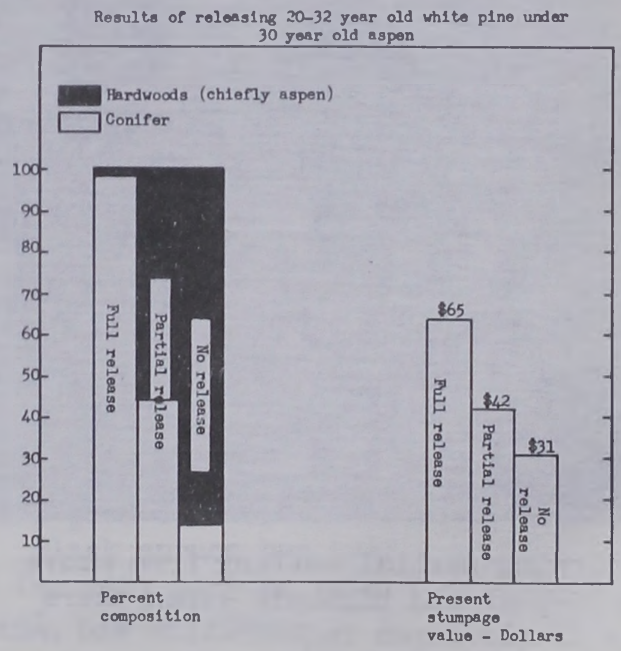
Reproduction Cutting in Mature Red Pine. Proper cutting in mature stands of red pine is the key to natural reproduction of this type. Present owners of red pine stands are vitally interested in maintaining these sites in pine forests. Several cutting studies in mature stands indicate reproduction can be established successfully. However, observations of two 140-year-old red pine stands on the Chippewa National Forest show that presence of a heavy overstory and brush competition seriously retard the growth and abundance of red pine seedlings (Technical Note No. 392). After treatment in 1944 one area, comparatively free of brush, had a volume of 19,000 bd. ft. per acre (98 sq. ft. basal area) and the second, a brushy area, had a volume of 29,000 bd. ft. per acre (124 sq. ft. of basal area). Under the lighter stocking red pine reproduction increased 15% in the area stocked and 30% in the number of seedlings, while under the heavy stocking there was a decrease of 4% in the area stocked and the seedling growth was poor. The annual growth rate of the overstory stands was quite comparable, 200 bd. ft. per acre per year for the lighter stocking and 177 bd. ft. per acre per year for the heavier stand.

Thinning Dense Stands of Young Jack Pine. Beneficial results from thinning jack pine were further substantiated by remeasurements of studies at both the Headwaters Research Center in Minnesota and the Northern Lakes Research Center in Wisconsin. Fifteen year results of thinning overdense young natural stands on the Superior National Forest show that an 8' x 8' spacing at 20 years of age provides good growing conditions for as long as 15 years after thinning. A 6' x 6' spacing and an untreated area showed a decided drop in growth between 10 and 15 years after thinning. Annual growth rates which were slightly higher than one cord per acre per year for a ten year period dropped

during the last 5 year period to .52 cords in the untreated area, .63 cords in the 6' x 6' spacing plot, and .94 cords in the 8' x 8' spacing area. The volume of pulpwood in cords per acre now available in trees 6" in diameter and larger is 6.4 on the check area, 15.5 on the 6' x 6' spacing, and 18.9 on the 8' x 8' spacing. To reestablish good growing conditions at contrasting stocking levels the plots were rethinned during the spring of 1953. The 6' x 6' spacing provided a cut of 6 cords per acre and the 8' x 8' spacing a cut of 8 cords per acre.

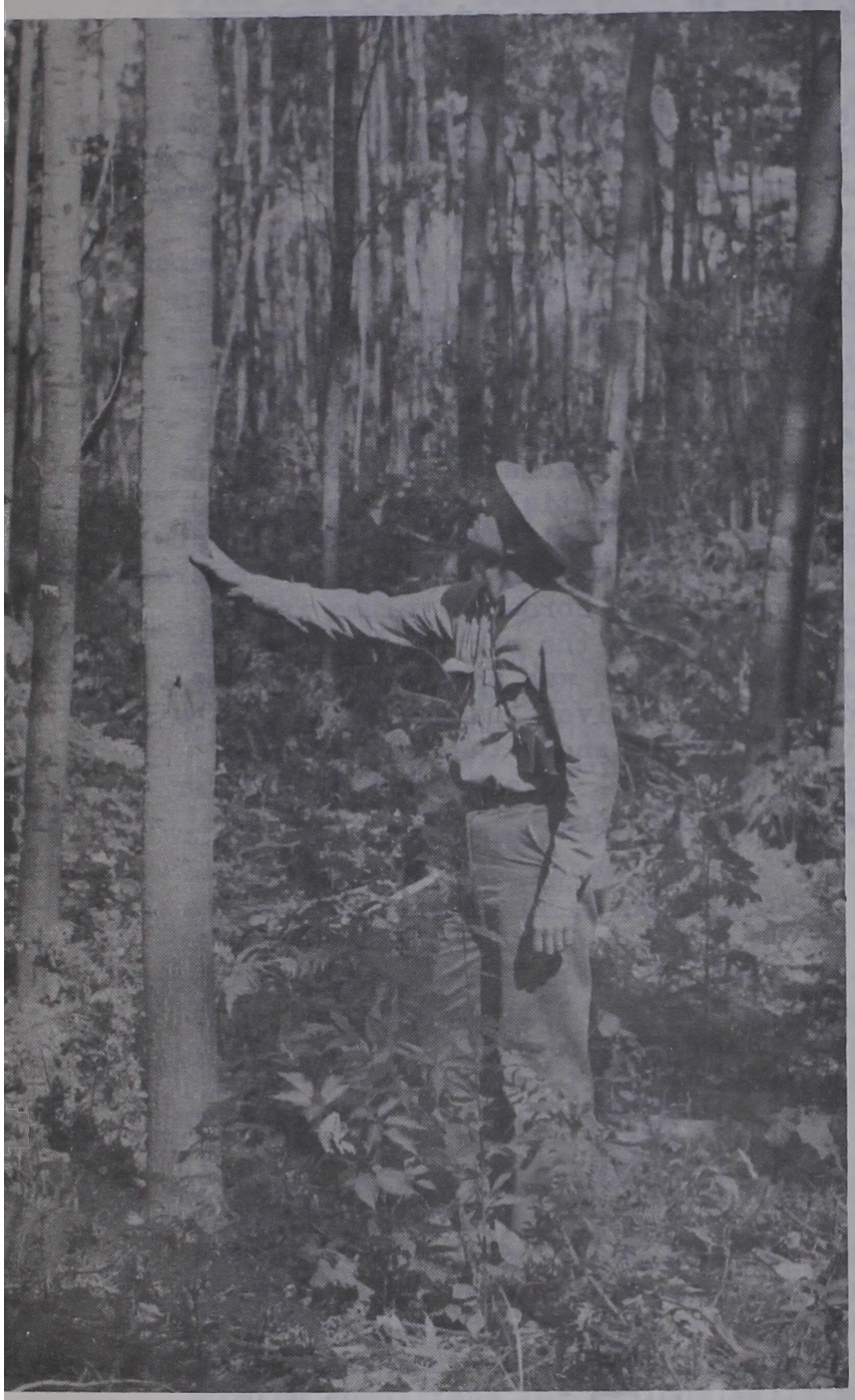
Release of White Pine Reproduction. Additional information on the value of timber stand improvement work is available from a study established in 1932 on the Chippewa National Forest. The purpose of the study was to determine the effects of release on the growth and development of white pine. Three one acre plots were established in 30 year old aspen with a white pine understory 20-32 years old. Treatments tested were full release, removing all the overstory; a partial release, removing only trees that interfered with the pine; and no treatment. Measurements made in 1952 give the following 20-year results: (1) Total cordwood in the full release is 24 cords, partial release, 25 cords; and no treatment, 26 cords. (2) Board foot volume is 5300 bd. ft. on the full release plot, 4300 bd. ft. on the partial release plot, and 4000 bd. ft. with no treatment. The greatest difference in the treatments is in the proportions of the total volume in conifers as compared with that in hardwoods (chiefly aspen). The cordwood volume in the full release is 99% conifer and 1% hardwood; the partial release has 44% conifer, 56% hardwood; where no treatment was applied the volume is 15% conifer and 85% hardwood. A comparative stumpage value of the timber on the three plots at current prices shows the full release area to be worth $65.00 per acre, the partial release area $42.00 per acre, and the no treatment area $31.00 per acre.

Present stand conditions call for a clear cut of the aspen, which is mature, on both the no treatment and partial release area. Poorly stocked residual stands will be left following the cut. The full release area has a stand that will give satisfactory yields for a long period under good management.



Plans for 1954. In 1954 plans are: (1) to initiate research in white pine to test the applicability to Lake States conditions of management techniques developed in the northeast, (2) to install a study of stocking levels in northern Minnesota, and (3) to investigate seedbed requirements for white pine in lower Michigan.

Aspen.



Following partial cutting from above in 35-year old bigtooth aspen there was little aspen regeneration and much encroachment of competing hardwoods.

Its expanded use during the last ten years has stimulated region-wide interest in managing aspen as a forest crop. However, the Station has given high priority to studies in the management of aspen for 25 years. During 1953 new work was initiated at the Headwaters Research Center in Minnesota and the Lower Peninsula Research Center in Michigan.

Aspen Site Factor Relationships. Aspen occurs on a wide range of soils. On good soils it makes excellent growth and yields are high. On poor soils, aspen becomes decadent before reaching merchantability. But, a reliable method of early site determination is not available to give forest managers a good estimate of the type of aspen land with which they are dealing. During 1953 with assistance from the Minnesota Commission of Iron Range Resources and Rehabilitation, the Station has undertaken a study, the objective of which is to identify those site factors that control aspen growth and development. Considerable research has already been done on this problem in several parts of the Lake Station region. The first job was to bring together the information available in a review of the literature. This

has been completed. In the next phase exploratory field studies have been started, including soil analyses of the good and poor sites.

Methods of Cutting Quaking Aspen. Twelve year results of a cutting study established in a 30-year-old quaking aspen stand show that forest managers will sacrifice growth if they wish to take early harvests from young stands by cutting the larger trees. The data indicate that cutting from above caused a slight loss in growth and total yield as compared to no cutting. The cut area, including the 1941 harvest, produced a yield of 24 cords as compared to 26 cords for the untreated area. Growth percent for the period 1941 to 1953 was 2.3% for the cut area as compared to 2.6% for the untreated area.

Methods of Cutting Bigtooth Aspen. Analysis of logging costs for different methods of cutting in 35-year-old bigtooth aspen in lower Michigan showed more efficient logging where the stand was clear-cut (Technical Note No. 407). This advantage must be balanced against the expected benefits from thinning when the thinned and untreated areas are clear cut about 1960.

Aspen Sucker Density. Studies carried on at the Pike Bay Experimental Forest in Minnesota show that thinning to as low as 600 to 900 stems per acre at age 13 can stimulate the growth of aspen. However, little is known of the possible influence of level of stocking during the first 10 years of the stand's life. So, a study was installed in 1952 in which young aspen suckers thinned to 250, 500, 1000, 1500 stems per acre were compared with untreated stands. First year results, in 1953, showed that the mortality in the thinned plots was from 0 to 13% as compared to 16% to 43% for the untreated areas. A heavy resprouting occurred in the thinned area, increasing the stand by 2,000 to 20,000 stems per acre. Re-thinning is necessary, therefore, to maintain initial differences. In contrast the untreated areas lost a substantial number of stems per acre.

Plans for 1954. For the coming year plans are: (1) to check the effectiveness of early thinning in bigtooth aspen, a practice already found to stimulate greater production in quaking aspen, (2) to continue field investigations of aspen site requirements in northern Minnesota, and (3) to assemble available data on aspen management preliminary to preparation of a summary publication on that subject.

Swamp Conifers.

There are about 6,300,000 acres of commercial swamp conifer forest in the Lake States. Black spruce, the most extensive type, occupies about half this area; white-cedar, tamarack, and mixtures of all these species with balsam fir account for the balance. Minnesota has the largest acreage of swamp conifers, and a good deal of the research in these types has been conducted there. Black spruce has held a strong position in the paper-making industry for many decades because of its long fibers and high density. The mixed conifer swamps of Michigan and

Wisconsin are important in the forest economies of those states. Within the past year research in the black spruce type has continued to go forward at the Headwaters Research Center in Minnesota, and new work is underway in mixed conifer swamps in Upper Michigan and in Wisconsin.

Cutting to Obtain Natural Reproduction in Mature Black Spruce. An extensive study to determine the best techniques for obtaining natural regeneration in mature swamp black spruce has been underway on the Big Falls Experimental Forest for the past 5 years in cooperation with the Minnesota Conservation Department.

Five cutting methods (clear cutting in strips, clear cutting in small patches, heavy partial cutting designed to remove the stand in two cuts, individual tree selection, and selective cutting in groups) aimed at obtaining regeneration are included, plus light partial cuttings designed to hold the present stands as long as possible, and check plots on which no cutting is done. In the three to five seasons since cutting, there have been no serious blowdown losses on any of these cuttings, in spite of the occurrence of several windstorms. Black spruce reproduction is now developing to some extent in each cutting method. A preliminary survey of regeneration made last fall indicated that best reproduction was in the clear-cut patches and strips, and in the heavy partial cuttings. There are indications that logging slash is still hindering reproduction on the clear-cut strips. A test of two slash disposal methods on clear-cut strips was begun at the close of the year to find a solution to this problem.

Cutting Methods in Mixed Conifer Swamps. A cooperative survey completed in 1951 indicated that past cuttings in mixed conifer swamps in Upper Michigan have resulted in adequate stands of reproduction, but that encroachment of the less valuable swamp hardwoods was common. This led to development of a cooperative study of methods of cutting swamp conifers to obtain reproduction of the valuable pulping species and salvage as much volume growth as possible from the established stand.

The study plan which provides for clear cutting in strips and in small blocks, and partial cuttings of diameter-limit, shelterwood, and selection types, has been used in laying out cooperative installations in Upper Michigan on the Upper Peninsula Experimental Forest, on lands of the Escanaba Paper Company at Newberry, lands of the Bonifas Lumber Company near Iron Mountain, and Patton Lumber Company property near Amasa. Additional cooperation is anticipated from landowners in further broadening the base of the study.

Restocking Deforested Conifer Swamps. A large acreage of formerly productive peat and muck lands in the Lake States have become almost totally deforested through the combined effects of forest fires, unwise cutting practices, drainage that encouraged peat fires, and brush invasion. Research to determine feasible methods of reforestation for such areas has been in progress at the Station for a number of years. A small-scale trial of seed-spotting with black spruce on sphagnum moss installed in 1947 on the Kawishiwi Experimental Forest in Minnesota, showed 48 percent of the seed spots stocked with well established seed-

lings. However, many swamps are so brushy that seedlings or plantings have little chance of success unless the competition can be reduced. So, in the fall of 1951, with the cooperation of several agencies, a tract of brushy swamp near Craigville, Minnesota was sprayed with herbicides from the air and a good initial kill of the brush obtained. An experimental planting of black spruce and tamarack was made on the area last spring. In spite of planting conditions, survival at the end of the first season averaged 52 percent for black spruce transplants, 30 percent for black spruce seedlings, and 64 percent for tamarack seedlings. Trees planted on slight hummocks survived the best.

Plans for 1954. During 1954 it is planned to (1) begin a study of non-commercial thinning in 25-year-old black spruce to fill a gap in the knowledge about optimum stocking requirements for the species, (2) continue expansion of methods-of-cutting study to other areas in the Upper Peninsula of Michigan, and (3) spray a brushy black spruce site with herbicide from the air as the first step in a test of rehabilitation through planting.

Balsam Fir.

An important development in the pulp and paper industry of the Lake States has been the increasing dependency on balsam fir in the manufacture of high grade paper. As a consequence, the cut of this once poorly-regarded species is now only a little behind that of spruce and seems likely to surpass the latter before long. Realizing that the balsam fir type is going to play a major role in pulpwood forestry in the Lake States, the Station has begun a systematic program of studies designed to furnish information on its management.

Cutting in Mature Stands. Cutting studies on a commercial scale have already been established in mature balsam fir, both pure and mixed with aspen, on the Pike Bay Experimental Forest in Minnesota and in a mixed stand on the Argonne Experimental Forest in Wisconsin. In these studies growth and yield under commercial practice is being compared with that obtained under various degrees of partial cutting. Although no results as to growth are yet available, reproduction counts show that the pure stands have an ever-present reserve of fairly well established balsam fir seedlings. Once cutting is made these seedlings begin to grow rapidly, and reproduction is assured (Technical Note 404). Additional cutting studies have also been established in stands of intermediate age.

Direct Seeding and Planting. The conversion of potential balsam fir land back to this type has received attention. Balsam fir plantations made in northern Wisconsin and on the Superior National Forest look quite promising. In particular one planted in 1941 near Ely, Minnesota demonstrates the remarkable ability of this species to compete successfully with brush. Direct seeding after disking also is being studied in Minnesota and Wisconsin.

Plans for 1954 are to install a study of non-commercial thinning.

Oak.

Advancement of knowledge about oak management will be slow until a more comprehensive program of studies can be initiated. A few small studies are being carried on in one of the timber harvest forests managed in cooperation with the Wisconsin Conservation Department and the Extension Forester. Last year's report described some of the studies of reproduction being made there. Additional oak management studies have been initiated in lower Michigan.

Reproducing Oak. Means of reproducing oak stands also is recognized as the principal problem in oak management in southern Michigan. In one study 40 acres of large sawlog-size red and white oak, growing on a good site, were clear cut to a 12-inch stump diameter during the winter of 1950 following an excellent acorn crop in the fall.

Herbaceous vegetation and seedlings of red maple, sugar maple, white ash, and yellow poplar came in on much of the ground area. Only about one third of the sample plots observed were stocked with oak seedlings. It appears that the young hardwood stands which will follow the clear cut logging of almost a pure oak stand will be mixed hardwoods with oak in the minority.

On the other hand, the Lansing Experimental Woods in southern Michigan, a 40-acre oak tract composed largely of a mixture of white and red oak, was partially cut during the fall of 1952, a poor seed year. An examination of the reproduction at the end of the first growing season after the partial cuttings revealed ample numbers of oak seedlings on each acre logged. Weedings will eventually be needed in some places because less desirable species of reproduction, such as eastern hophornbeam are crowding the more valuable oak seedlings.

Oak Sites. Scant information has been available on the Lake States portion of the commercial oak range in regard to those site characteristics that affect the growth and development of oak. However a study in southern Michigan (published in 1953 as Michigan Agr. Expt. Sta. Bul. 236), showed that the following soil and land features have considerable effect on the growth of oak in southern Michigan: (1) Texture of the subsoil, (2) presence of moist substrata layers within approximately 4 to 10 feet of the soil surface, (3) steepness of the slope, and (4) position on the slope.

Various combinations of these site characteristics for land on which oak commonly grows in southern Michigan are grouped into five site classes as follows:

| Site Class | Mean annual growth of dominant and codominant oak at 80 years of age. | |
|---|---|---|
| | Cu.ft. 1/ | Bd.ft. 2/ |
| Very poor | 12 | 25 |
| Poor | 17 | 43 |
| Medium | 24 | 70 |
| Good | 35 | 130 |
| Very good | 54 | 210 |

1/ Gross volume of entire stem, less bark.
2/ International 1/4 inch log rule.

Effect of Bucking Practice on Log Grade. A cooperative study with Michigan State College of log cutting on a commercial logging operation revealed that an increase of 12 percent in the volume of No. 1 logs could have been attained if standard log grading rules had been properly applied by the cutters in the woods (Technical Note No. 406). Of the 242 logs cut on the operation, 42 logs (17 percent of those cut), representing 24 percent of the total lumber volume, were improperly bucked. It was found that only four more power saw cuts would have been required to increase their value at roadside by $7.50 per M. without increasing the volume of grade No. 3 logs.

## Management of Pine Plantations

The management of our more than one million acres of successful pine plantations through their early developmental years presents special problems different from those of young natural stands. Planted stands usually start out with fewer and more evenly spaced stems per acre which results in more uniform stand conditions than those created by nature. Plantations usually are understocked during the early stages of their development, while the opposite often is true of natural stands. Plantations are more adaptable to intensive forest practices because from the start they are the result of planning.

Some of the cultural practices in plantation management for which research must find the best intensity and most economical technique are release, pruning, and thinning. Since more than one half of the pine plantations in the Lake States region are in lower Michigan, most of the plantation management studies are concentrated in this problem area. Some work is also being done in northern Minnesota with the assistance of the Iron Range Resources and Rehabilitation Commission.

Some Effects of Spacing on Height Growth.

After 35 years, dominant red pines in a lower Michigan plantation spaced 4 x 4 feet, were shorter than those at wider spacings from 6 x 6 to 8 x 9 feet. Because of the poor dry site differences were attributed to competition for available soil moisture rather than for crown growing space.

Studies made on sites with more available moisture have failed to show a similar relationship between growing space and height growth. Therefore, part of the closely spaced planting was thinned to 8 x 8 feet to see if height growth improves on this area as competition is reduced.

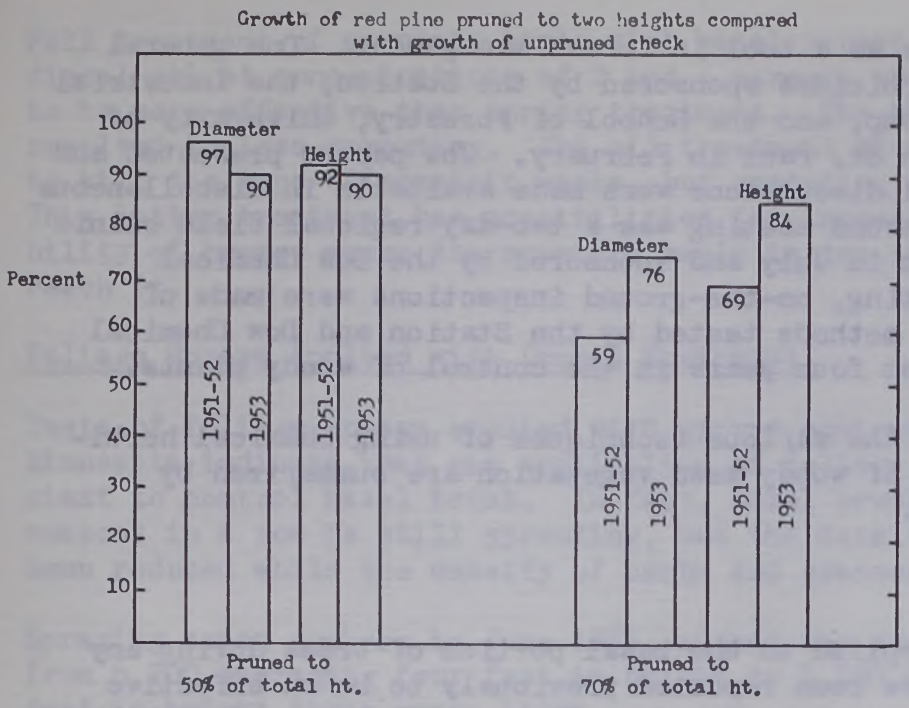
Pine Pruning Costs.

Because of the limby character of the trees in pine plantations, artificial pruning is necessary to produce high quality logs and lumber in a reasonable length of time. Studies in lower Michigan showed that about 10 man-minutes, on the average, is required to prune a red or white pine tree to 17 feet, the length considered necessary to produce a clear 16-foot sawlog with adequate stump and trim allowances. Pruning costs increase, however, as the work progresses up the stem. The average cost in labor time is about 75 percent greater per lineal foot when pruning that section of the bole between 12 and 17 feet than it is for the section below 12 feet.

The study also showed that there was no significant difference in man-hours consumed when pole saws were compared with ladders and hand saws in pruning pine to 17 feet. However, the ladder and hand saw proved much less tiring than the pole saw and made it easier to cut close to the main stem. Moreover, a short pole saw with a curved blade mounted on a single bit axe handle proved adaptable to low pruning, especially in trees where branches persisted close to the ground, and made it possible to prune up to 10 feet without extra effort. This permits pruning a merchantable log length in one operation, something that can not usually be done with the hand saw alone.

How High to Prune.

The effects of different intensities of pruning on the height and diameter growth of planted red and white pines are being explored so that economical pruning schedules can be set up. Three-year results reported in 1952 showed that for planted red pine growing under all of the conditions tested in lower Michigan, up to 50 percent of the total height can be safely pruned. Pruning to 70 percent of total height, however, resulted in decreased growth for three years.




Recent examinations of the study, indicate that these severely pruned trees will approach normal growth four years after being pruned to 70 percent of total height.

Plans for 1954. In the coming year plans are (1) to initiate construction of yield tables for red, white, and jack pine plantations, (2) to cooperate with Michigan State College in issuing a publication on pruning pine plantations in Michigan, and (3) to install stocking level studies in jack pine and red pine plantations in northern Minnesota in cooperation with the Iron Range Resources and Rehabilitation Commission.

## Use of Chemical Herbicides in Forest Management

Progress of the Station in the field of chemical herbicide research during 1953 was mainly in further substantiating earlier results reported from time to time during the past several years. No new chemicals were tested, although varying techniques were tried in further attempts to adapt previously reported treatments to local conditions. Several cooperative aerial spraying trials were made in the most widespread use of this means of distributing herbicides to date.

More interest in the chemical control of woody weed vegetation was shown during 1953 by agencies and companies in the region than in previous years. Part of this interest came from two regional herbicide clinics held during the past year as well as from the gradual acceptance

of chemical herbicides as a tool in forest management. One general clinic on chemical herbicides sponsored by the Station, the Industrial Forcsters Research Group, and the School of Forestry, University of Minnesota, was held in St. Paul in February. The papers presented and summaries of the panel discussions were made available in Miscellaneous Report No. 21. The second meeting was a two-day regional field clinic held in lower Michigan in July and sponsored by the Dow Chemical Company. At this meeting, on-the-ground inspections were made of various chemicals and methods tested by the Station and Dow Chemical Company during the past four years in the control of woody plants.

The current status of the various techniques of using chemical herbicides for the control of woody weed vegetation are summarized by method of application.

Basal Sprays.

Chemical oil sprays applied to the basal portion of trees during any season of the year have been reported previously to be an effective method of controlling scrub hardwoods. The general year-round chemical mixture recommended is 12 lbs. of 2,4,5-T[3/] acid per 100 gallons of No. 3 diesel oil. The bases of the stems must be thoroughly wetted with this mixture to a height of nearly two feet for effective control.

Because of the large volume of herbicide that must be applied to the base of the trees as they increase in size, basal sprays are generally not practical for stems larger than four to six inches in diameter. However, aside from cost considerations the size of the stem is no problem as far as control is concerned as long as the chemical can be supplied without difficulty.

Basal sprays have been found to control scrub oak (all species), beech, red maple, cherry, and other common hardwoods in the region without serious sprouting for two or three years. After three years sprouts develop from below the root collar of some species, such as red maple.

Although basal sprays can be applied at any season of the year for general control measures, the season has considerable effect on the dosage and concentration of the chemical needed, rate of top kill, and subsequent sprouting. For example, basal sprays applied to aspen during the dormant season and early growing season before full leaf development, delay sprouting until the second growing season after treatment. However, scrub aspens treated with basal sprays during the summer after full leaf development have not sprouted four years after the treatment. In general, most Lake States hardwoods are controlled best when treated with basal sprays during the summer.

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3/ Generally marketed in a concentration of 4 lbs. of pure acid per gallon.

Fall treatment of mountain maple with basal sprays of 2,4,5-T in diesel oil at concentrations of 2 and 4 percent by volume was found to be more effective than spring treatment. The higher concentration resulted in less sprouting. The oil treatment alone was toxic enough to kill the tops of mountain maple, but sprouting was very prolific. This latter treatment has possibilities for increasing the availability of browse where the mountain maple is too tall for deer to reach it.

Foliage Sprays Applied with Ground Equipment.

Tests of foliage sprays applied with ground equipment in northern Minnesota indicate that one application of foliage spray is insufficient to control hazel brush. In fact, hazel brush sprayed three seasons in a row is still sprouting, but the density of stems has been reduced while the density of herbs and grasses has increased.

Spraying aspen suckers in June 1951 reduced the number of stems from 6,200 averaging four feet in height to 1,100 stems less than two feet in height three years later.

Preplanting release by foliage sprays of brushy areas the summer prior to machine planting of red pine appears to have merit according to tests made in northern Minnesota in 1950. Although the brush sprouted heavily, only 42 percent of the pine needed release in 1953 compared to 71 percent where no spraying was done.

Aerial Application of Foliage Sprays.

Observation of tests of aerial spraying for release of conifer reproduction made in the Lake States indicates that results will be quite variable and seldom fully effective. Under favorable conditions 2 pounds per acre or less of 2,4-D or 2,4,5-T have severely injured all common broadleaf tree and shrub species considered as weeds. Scrub aspen is apparently difficult to kill with aerial sprays and most of the shrubs sprout prolifically after one application.

Effects of the herbicides on the conifers was found to be negligible when spraying was done in late July or during August. Red pine showed a drooping of the needles in several cases but this was thought to be temporary and not indicative of any real damage. Black and white spruces are quite resistant to the chemicals used.

Opportunities for increasing the effectiveness of aerial spraying of herbicides appear to lie in spraying earlier in the season when weed species are more susceptible, and in obtaining more uniform coverage through improved use of communications, better boundary markers, tighter specifications on acceptability of weather conditions, and more effective patterns of flight.

Chemical Frill Girdling.

A combination of mechanical and chemical methods has been developed for Lake States conditions to provide satisfactory control of most scrub hardwoods for forest management purposes. This method consists of a continuous cut around the trunk of the tree through the bark with an axe or other cutting tool into which is poured a one percent mixture (by volume) of 2,4,5-T and diesel oil. If the frill girdle is made at a convenient chopping height about one half of treated scrub oak stems develop sprouts. However, the sprouts that do develop are less numerous and less vigorous than those that develop from mechanical girdling where the chemical is not used. If less sprouting is desirable, the trees can be frill girdled close to the ground. The closer the chemical frill girdle is to the root collar the less sprouting for most hardwood species. The frill method is most easily applied to trees larger than three to four inches in diameter. Trees smaller than this size can be cut off and the freshly cut stump treated with the chemical.

This method is well suited to controlling unwanted hardwoods on extensive pine release and timber stand improvement operations. One man with about three gallons of chemical can usually treat the frills cut by two to three axemen during one half day.

The chemical frill method of control is less expensive on most operations than regular mechanical control where the trees are cut and girdled, and sprouting is much less reduced following chemical treatment.

Ground Applications of CMU.

Indications to date in northern Minnesota are that CMU (3- (p-chlorophenyl)-1, 1-dimethylurea) applied at the rate of 25 to 40 pounds per acre will reduce grass and herb density to a level of one third to one half compared to check areas where no chemical was used.

Plans for 1954. It is planned, in 1954, to (1) test the tolerance of pine to various herbicide foliage sprays applied during June, July, and August in Lower Michigan, (2) test the effectiveness of foliage sprays for low release of plantations during June, July, and August in northern Minnesota, (3) prepare a regional summary on the use of chemical herbicides as a tool for forest managers, and (4) summarize experience in the region to date with aerial spraying of herbicides.

## Progress in Tree Improvement

Since 1928, only five years after its establishment, the Lake States Station has carried on a few projects in the broad field of forest genetics. This has included seed source studies, tests of exotic species, tests of poplar and pine hybrids, and one breeding study. Genetics work has received new impetus since 1951 when a regional cooperative jack pine seed source study was initiated. Growing interest

in forest genetics found expression in a Lake States Forest Genetics Conference, sponsored by the Station, and its outgrowth, the Lake States Forest Tree Improvement Committee.

The Lake States Forest Genetics Conference.

In response to a growing awareness of the importance of tree improvement in the region, the Lake States Forest Experiment Station in 1953 sponsored a forest genetics conference at Eagle River, Wisconsin. The conference was attended by 56 foresters, geneticists, plant pathologists, entomologists and biologists from the universities, state conservation departments, forest industries, and federal forestry agencies of Minnesota, Wisconsin, Michigan, and representatives from Ohio, Ontario, Massachusetts, and California. At the conference there were (1) reports of forest genetics work done by various agencies in the Lake States, Canada, the Northeast, the South, the Northwest, and Europe; (2) discussions of genetics problems needing study in (a) the growing of more productive and better quality trees, (b) the production of maple syrup, (c) developing insect- and disease-resistant trees, (d) producing trees resistant to wildlife damage and also those more productive of wildlife values, and (e) the development of trees best adapted to various Lake States site conditions; and (3) discussion of bases for planning future forest genetics research in the Lake States.

The Lake States Forest Tree Improvement Committees.

Out of the Lake States Forest Genetics Conference there developed the Lake States Forest Tree Improvement Committee, the purpose of which is "to encourage and coordinate forest genetics activities in this region". The Committee of 9 was selected to represent the subject matter interests and agencies concerned in forest genetics work in the region. Its members represent the state conservation departments of Minnesota, Wisconsin, and Michigan; the universities of Minnesota, Wisconsin, and Michigan, and Michigan State College; forest industry; and the Lake States Forest Experiment Station.

These 9 members, with the addition of 7 well-qualified men outside its membership, have been grouped into the following four temporary subcommittees: seed collection zones, tree and stand selection, bibliography and directory, and projects for study. A preliminary report on selecting superior trees and stands in the Lake States is in process of review. Reports by the other subcommittees are in preparation.

The Regional Jack Pine Seed Source Study.

In 1951, cones were collected from 29 jack pine stands well distributed over the commercial range of jack pine in the Lake States. This was the active beginning of a regional project, planned jointly by the Station and the University of Minnesota Forestry School. Stock, now growing in State nurseries in Wisconsin and Minnesota, will be field-planted in the spring of 1954 in 17 test plantations distributed as

follows: (1) Minnesota - 2 state forests, 2 national forests, 1 state experimental forest, and 1 university forest; (2) Wisconsin - 2 county forests, 2 industrial forests, 1 national forest, and 1 Station experimental forest; and (3) Michigan - 3 state forests, 1 university forest, and 1 national forest. During 1953 these 17 experimental blocks were selected and laid out into plots; on most of them ground preparation was completed.

Testing Pine Hybrids.

Small lots of jack pine-lodgepole pine hybrids and the two parent species were field-planted on experimental areas in northern Minnesota, northern Wisconsin, and the Lower Peninsula of Michigan. The stock was grown by the Station in the Hugo Sauer State Nursery (northern Wisconsin) from seed supplied by the Institute of Forest Genetics in California.

Other Tree Improvement Activities.

The Station prepared a work plan for testing Danish hybrid willow cuttings which had been purchased by several companies in the region, and arranged to plant one replication in northeastern Wisconsin. Because of quarantine regulations, the cuttings were not available for planting in 1953.

Cooperation was continued with persons and agencies interested in tree improvement through the collection of seeds, pollen, and other plant materials for use both within and outside the region.

Plans for 1954.

During the ensuing year it is planned to (1) aid in the planting of replications of the regional jack pine seed source study, and (2) assist in the work of the Lake States Forest Tree Improvement Committee.

## Nursery Research

Chemical Weed Control.

One of the great advances in nursery practice has been the reduction in expenditures for hand weeding through the use of chemical herbicides. The use of mineral spirits has become more or less standard in conifer nurseries. Search continues for more effective herbicides, and for more versatile ones adapted for use with broadleaf planting stock.

In 1953 an experiment was conducted at Hugo Sauer Nursery to evaluate weed control possibilities of a number of chemicals applied immediately after sowing. Chemicals tested were Chloro IPC, Santobrite, CMU, Nix, Oktone, and Hydrin. Tree species tested were jack pine, red pine, black spruce, black locust, redbud, yellow birch, paper birch, and sweet gum. Based on observations to date, Hydrin, applied at 10 to 20 gallons per acre, shows considerable promise as an effective treatment with little or no adverse effect on tree stand or vigor.

Test beds of lupines in the Hugo Sauer State Nursery, northeastern Wisconsin.

Soil Improvement Crops.

Since 1951, experiments have been under way at Northern Lakes Forest Research Center to find better soil improvement crops for forest nurseries in the cooler climatic belts of the Lake States.

The 1953 trials involved different species of lupine obtained from Bureau of Plant Introduction, the Spooner Substation of the Wisconsin Agricultural Experiment Station, cooperating German forest nursery, and commercial sources in southeastern United States.

In these tests, four annuals made a good record in terms of bulk organic matter. These were Florida speckled sweet, bitter blue annual, white bitter, and sweet yellow annual lupines. Perennial lupine had moderately good first year production of organic matter and may have promise where it can be left for two or more years.

These species now appear ready to be tested on a larger pilot scale in nurseries in spring seedings in cool-summer temperature areas.

## Tests of a Portable Wood Chipper

During 1953 a portable wood chipper, designed to chip brush and wood material up to six inches in diameter, was tested in lower Michigan, using oak, aspen, and pine. About 200 cubic feet of chips were produced per hour from one cord of rough wood. Operational costs of the machine itself, exclusive of labor and fixed costs of the investment,

Field inventory is about 3/4 done; except for drain, other phases of the project are not so far advanced (See accompanying maps and tables). The aim is to complete field work on the current cycle during calendar year 1955. Following the present survey, plans are to maintain a small "continuous inventory" in each state to keep abreast of periodic changes resulting from growth and drain until such time as changing conditions necessitate another thorough field survey.

## Timber Resource Review

A national reappraisal of the whole forestry situation in the United States comparable to reports made by the Forest Service in 1920, 1933 and 1945 was announced a year ago. During 1953 the Station has applied a considerable share of its effort toward assembling reliable up-to-date statistics and comment contributing to this national project. The principal tasks undertaken by the Station have been to:

1. Revise the inventory of forest area, timber volume, growth and drain for the three Lake States and North Dakota, incorporating latest forest survey data.

2. Report on the production of lumber, pulpwood, veneer, poles, posts, fuelwood and all other forest products for the year 1952 and determine the resultant drain on standing timber.

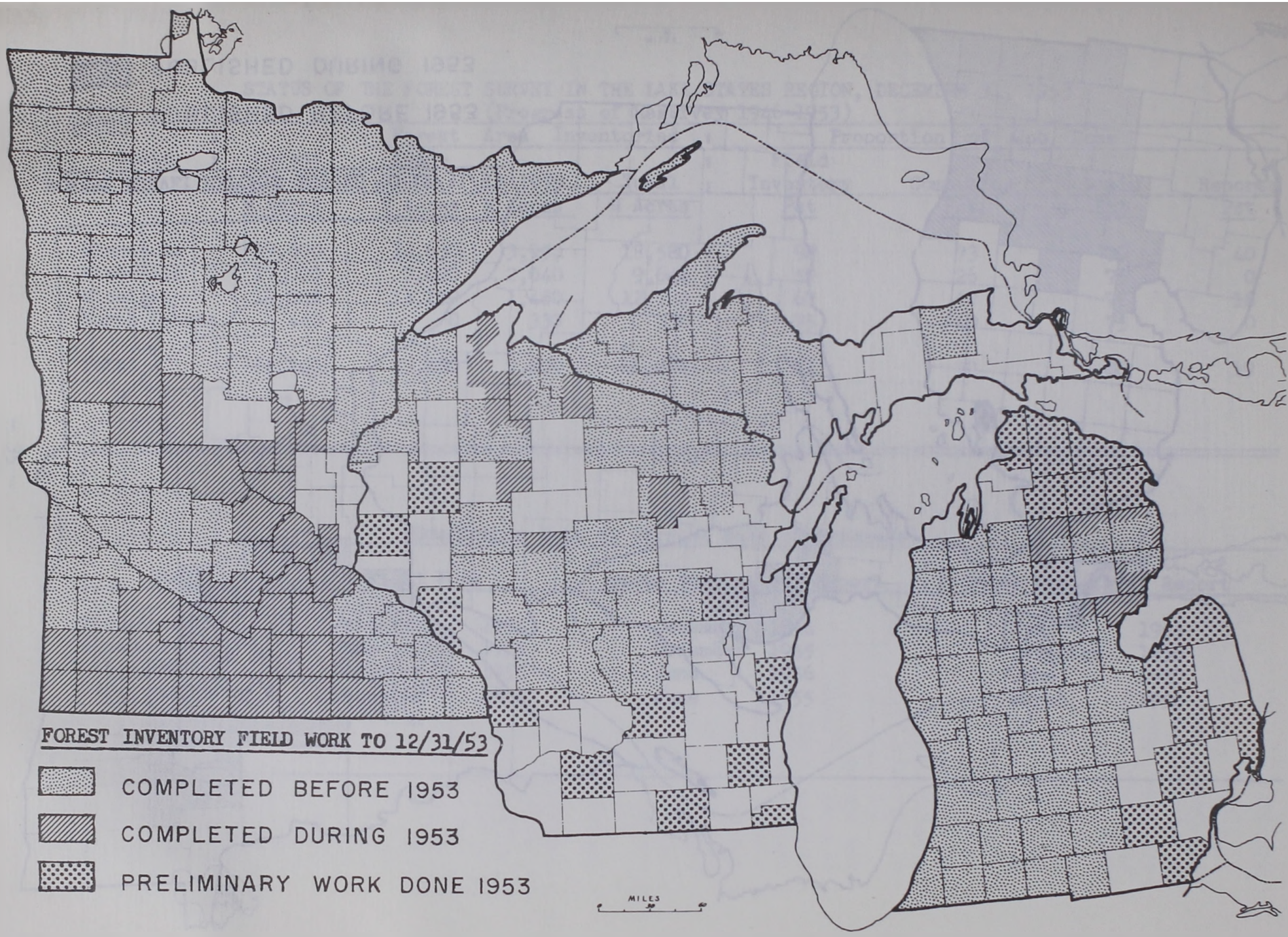
3. Study the amount of wood residue left in logging and milling and ascertain the extent of its utilization for fuel and other products.

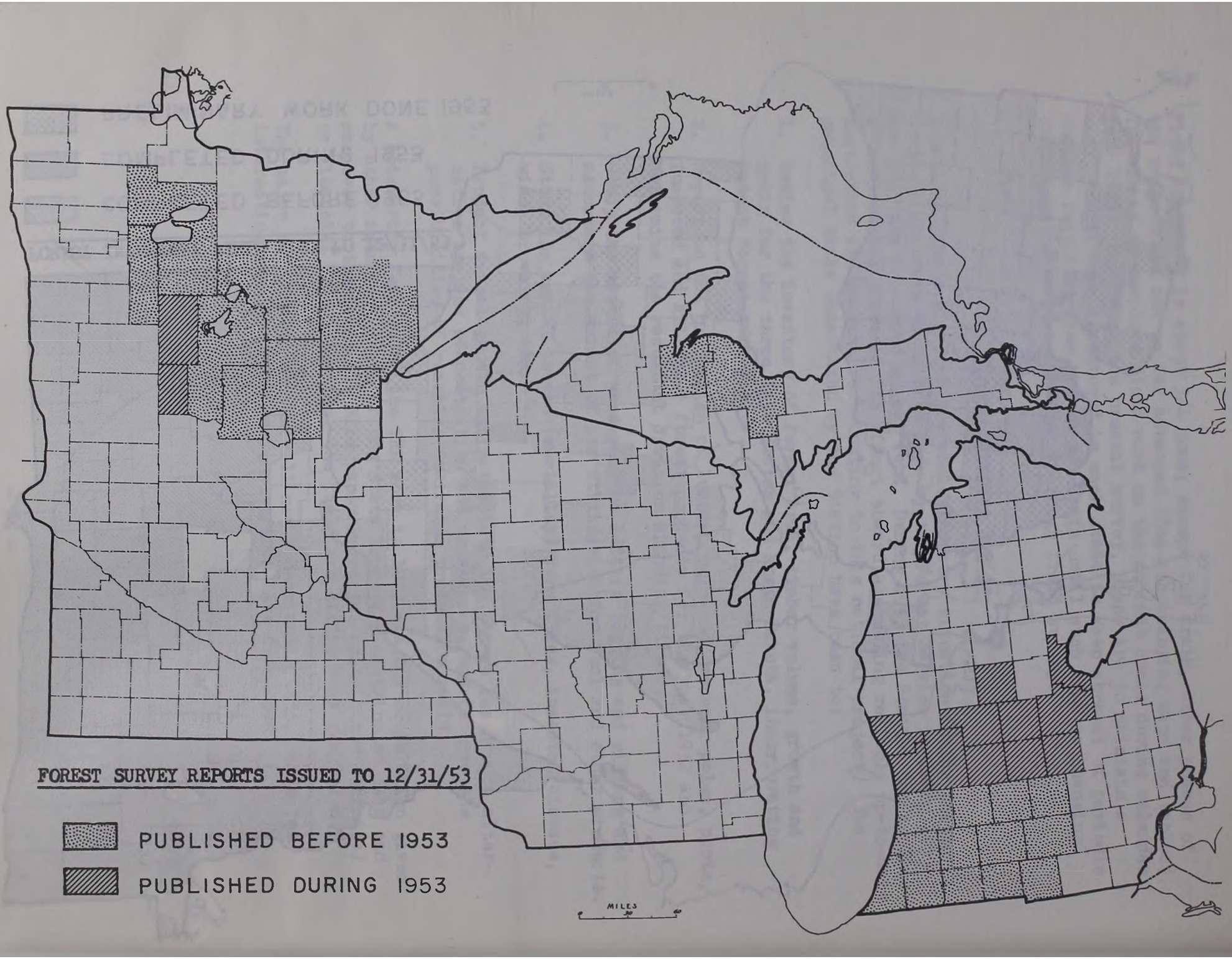
4. Study the annual losses (mortality) from fires, insects, disease, wind, browsing, etc.

5. Project annual growth estimates into the future based upon alternative systems of protection and management, and analyze the possibilities of reaching desirable production goals.

A noteworthy feature of the TRR work in 1953 was the cooperation given by other agencies. Each of the State Foresters contributed data and manpower to the project. Nine paper companies contributed technical or financial help in getting the field and office work completed.

The major results of the TRR will not appear until 1955, but a few interesting sidelights on regional trends have developed.


FOREST INVENTORY FIELD WORK TO 12/31/53
COMPLETED BEFORE 1953
COMPLETED DURING 1953
PRELIMINARY WORK DONE 1953
MILES


FOREST SURVEY REPORTS ISSUED TO 12/31/53
PUBLISHED BEFORE 1953
PUBLISHED DURING 1953
MILES

STATUS OF THE FOREST SURVEY IN THE LAKE STATES REGION, DECEMBER 31, 1953
(Progress of Resurvey 1946-1953)

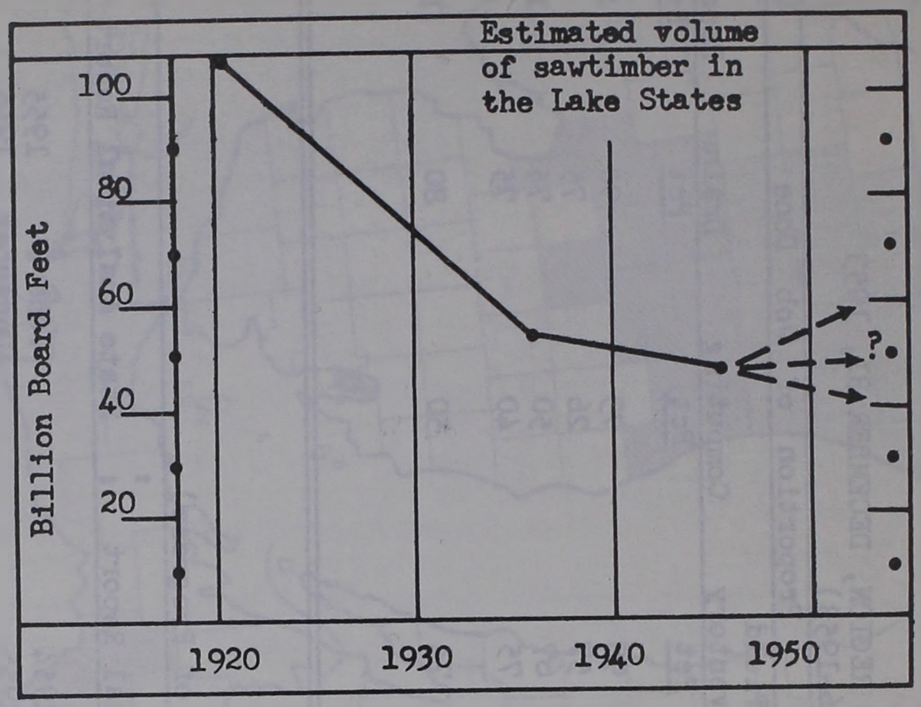
| State | Forest Area | Forest Area Inventoried 1946-1952 | Forest Area Inventoried In 1953 | Forest Area Inventoried Total | Proportion of Job Done: Field Inventory | Computing | Drain | Reports |
|---|---|---|---|---|---|---|---|---|
| | M Acres | M Acres | M Acres | M Acres | Pct | Pct | Pct | Pct |
| Minnesota | 19,000 | 14,630 | 3,950 | 18,580 | 98 | 73 | 90 | 40 |
| Wisconsin | 17,000 | 7,600 | 2,040 | 9,640 | 57 | 26 | 75 | 0 |
| Michigan | 19,000 | 11,250 | 1,480 | 12,730 | 67 | 50 | 75 | 16 |
| North Dakota | 440 | 0 | 330 | 330 | 75 | 40 | 75 | 0 |
| Total | 55,440 | 33,480 | 7,800 | 41,280 | 74 | 50 | 80 | 19 |

(Completion Date at Current Rate of Progress)

| State | Field Work | State Statistical Report | State Analytical Report |
|---|---|---|---|
| Minnesota | January 1954 | December 1954 | June 1955 |
| Wisconsin | June 1955 | December 1955 | December 1956 |
| Michigan | December 1955 | June 1956 | June 1957 |
| North Dakota | December 1954 | June 1955 | March 1956 |

Inventory.

From 1920 to 1936 there was a sharp drop in estimated sawtimber volume in this region.

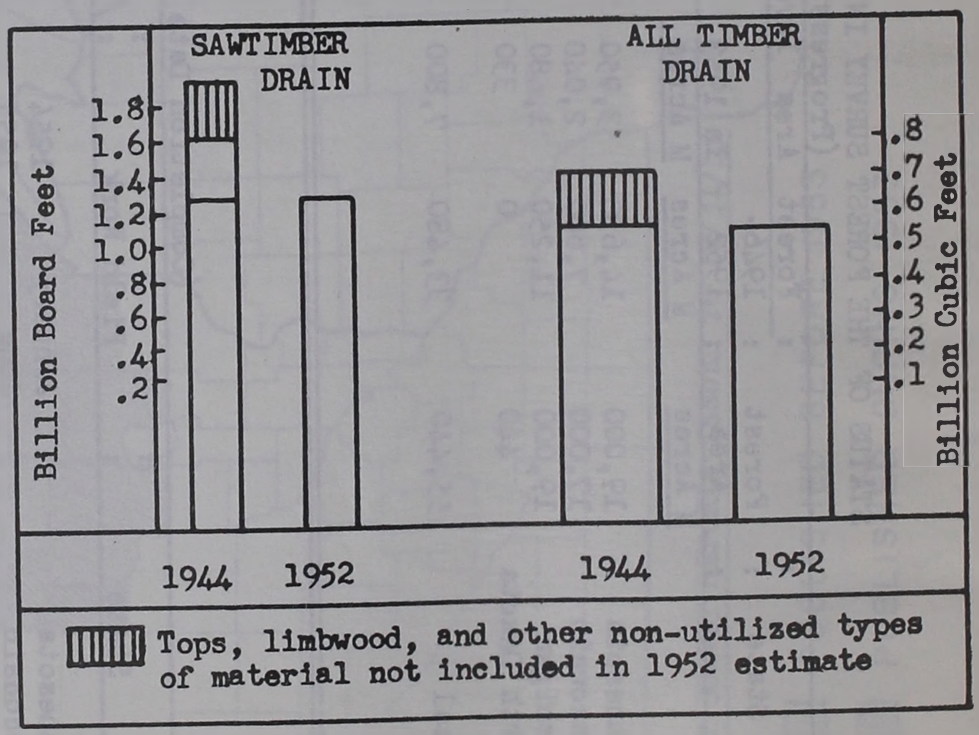



Estimates for the reappraisal, made without additional field work in 1945, projected this downward trend but at a slower rate.

New survey figures are showing continued decline in virgin timber supplies but offsetting this a steady rise in second growth, especially of oak and other hardwoods. The new 1952 estimate will be watched with great interest to see whether or not the corner has actually been turned and growing stock volume is now on the up-grade.

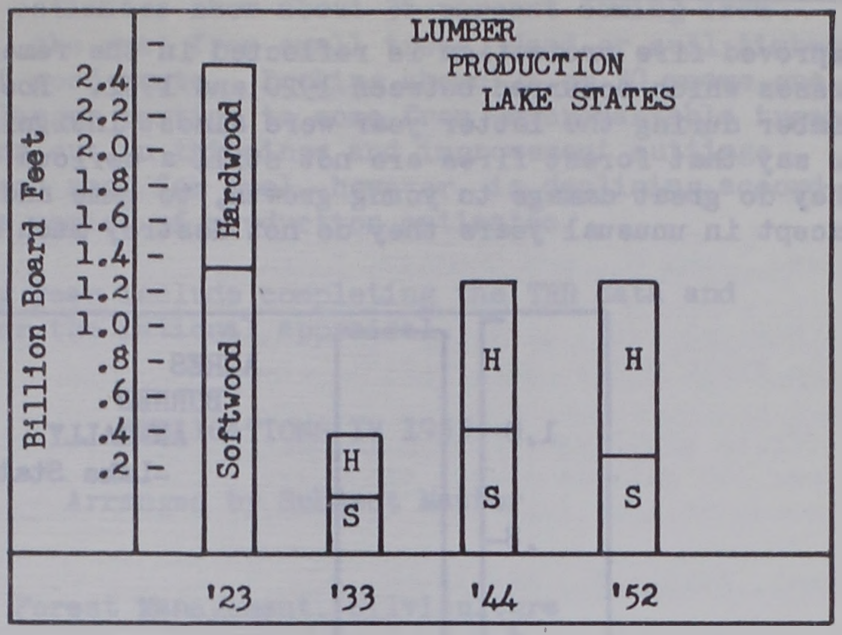
Annual Drain.

For 1944, the year used in the last national Reappraisal, annual logging drain in the Lake States was estimated to be 1,886 million board feet or 697 million cubic feet. The estimate for 1952 is but 1,242 or 541 million cubic feet. Some of this difference has been caused by changes in standards of measurement. Estimated by 1952 standards the 1944 cutting drain would have been 1,635 million board feet or 600 million cubic feet, still significantly larger than 1952 drain.



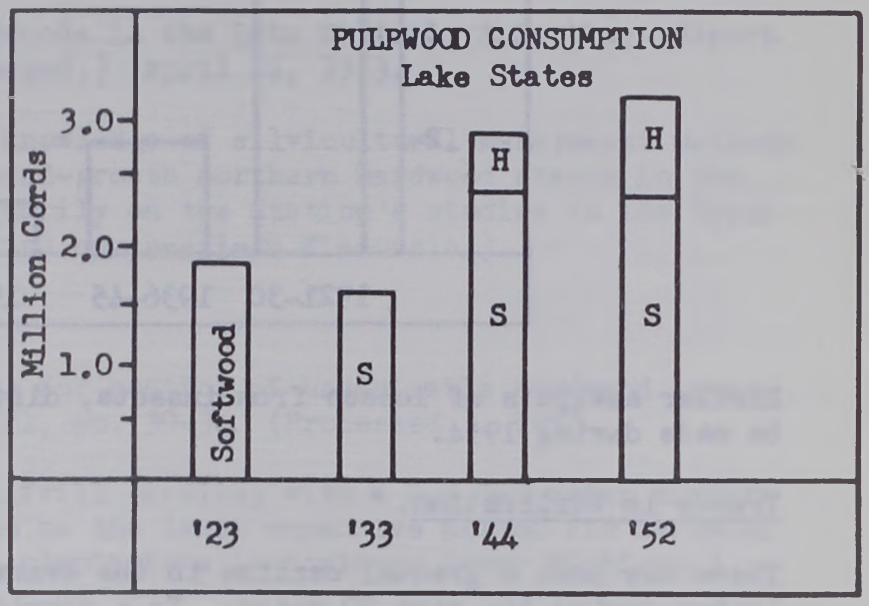
Lumber Production.

Output in 1952 was not much different in total quantity from that in 1944. It was substantially lower than 30 years ago but more than twice as large as during the depression year 1933. The proportion of softwood, particularly hemlock, has declined in recent years.



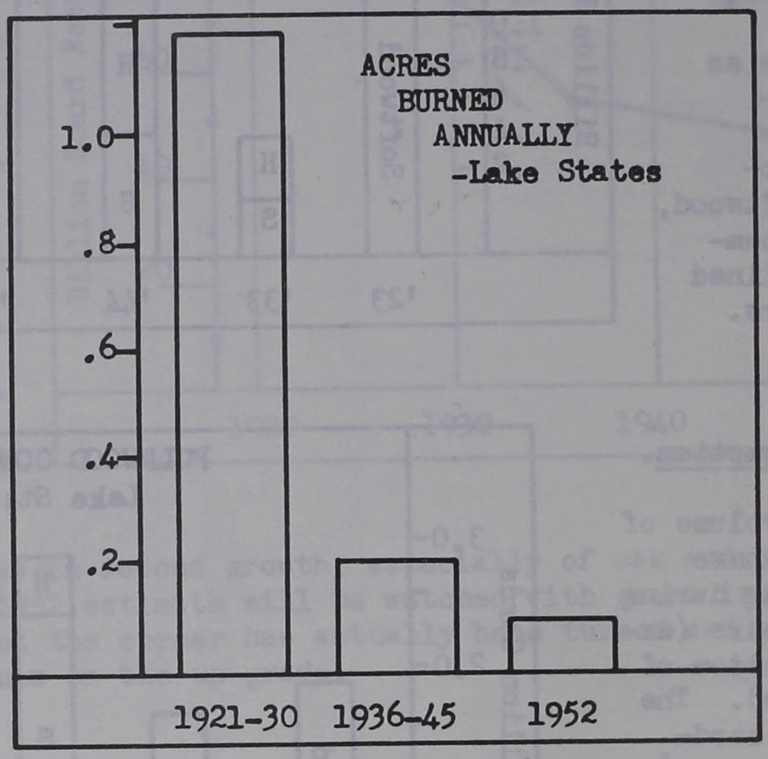

Pulpwood Consumption.

Estimates of volume of pulpwood used have been increasing during the past 30 years (except at the bottom of the depression). The proportion of hardwoods (mainly aspen) has risen from an insignificant percentage in 1923 to about 34% in 1952.



Losses from Fire.

Improved fire protection is reflected in the remarkable drop in fire losses which occurred between 1920 and 1952. Losses of merchantable timber during the latter year were almost insignificant. That is not to say that forest fires are not still a serious threat to the forests. They do great damage to young growth, to game and to the soil, but except in unusual years they do not destroy much merchantable timber.




Similar analysis of losses from insects, disease, animals and wind will be made during 1954.

Trends in Utilization.

There has been a gradual decline in the average size of logs used for lumber during the past 30 years. To a considerable extent jack pine, spruce, balsam fir, white-cedar and tamarack have taken the place of white pine and hemlock; aspen has replaced larger hardwoods. Now, nearly one-sixth of the lumber is sawed from trees classed as pole-timber rather than sawtimber in the forest inventories. Because of this development, it requires standing sawtimber to the amounts of only 858 board feet (softwood) or 831 board feet (hardwood) to produce 1,000 board feet of lumber. The drain on sawtimber, therefore, is not as great as one might expect from lumber production statistics.

Utilization of pulpwood, although it varies some from year to year and place to place, is generally closer than 30 years ago. Jack pine, balsam fir and hemlock which were used to about a 5-inch top then, are now accepted to 4 inches. Spruce now is used to a 3½-inch top and in places 2½ inches. Quality standards are somewhat less rigorous.

In fuelwood, recent estimates show about 36 percent coming from merchantable timber, the rest from small trees, dead or cull timber and various kinds of wood waste. Looking ahead 25 or 30 years one may expect an even larger portion to come from unmerchantable trees, including those taken out in thinnings and improvement cuttings. Total quantity of wood used for fuel, however, is declining according to the Station's series of production estimates.

Plans for the coming year include completing the TRR data and analyses required for the national appraisal.

## PUBLICATIONS IN 1953

### Arranged by Subject Matter

### Forest Management, Silviculture

Arbogast, Carl, Jr.

Managing northern hardwoods in the Lake States. L.S. Misc. Report No. 23, 11 pp. (Processed.) April 21, 1953.

(A summary of current knowledge of silvicultural management methods for old-growth and second-growth northern hardwood stands in the Lake States, based primarily on the Station's studies in the Upper Peninsula of Michigan and northeastern Wisconsin.)

Arend, J. L.

Chemical frill girdling for control of undesirable hardwood trees. L.S. Misc. Report No. 21, pp. 30-34. (Processed.) 1953.

(Described is chemical frill girdling with a 2,4,5-T ester mixture in oil which appears to be the least expensive method for hardwood control in most forest plantations in northern Lower Michigan.)

*Arend, John L.

Controlling scrub aspen with basal sprays. Down to Earth (Dow Chemical Co.) 9(1): 10-11. illus. Summer 1953.

(Soaking the basal two to three feet of aspen trees with a 50/50 mixture of 2,4-D and 2,4,5-T esters in diesel oil (12 pounds acid per 100 gallons oil) following full leaf development in the summer gave good control.)

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*Publications marked by asterisk are not available for distribution by the Station.

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Scrub aspen control with basal sprays. L.S. Tech. Note No. 401, 1 p. (Processed.) July 1953.

(See "Controlling scrub aspen with basal sprays" on previous page.)

*Arend, John L., and Coulter, L. L.

Chemical frill girdling for pine release in Lower Michigan. Down to Earth 8(4): 2-4. illus. Spring 1953.

(Frill girdling with application of 2,4,5-T esters (4 pounds acid per 100 gallons diesel oil) gave satisfactory control of scrub hardwoods at less than half the cost for hand release.)

Gysel, Leslie W., and Arend, John L.

Oak sites in southern Michigan: their classification and evaluation. Mich. State College, Tech. Bul. 236, 57 pp., illus. March 1953.

(A site classification for oak in Lower Michigan is based on texture of the subsoil, presence of moist substrata within 4-10 feet of the soil surface, steepness of slope, and position on the slope.)

*Arend, John L.

Review of "Soils and Land of Michigan," by J. O. Veatch, 240 pp., illus. Mich. College Press, East Lansing, Mich. 1953. Jour. For. 51(11): 829. Nov. 1953.

Conover, David L.

Effects of competition on red pine and white pine reproduction. L.S. Tech. Note No. 392, 2 pp., illus. (Processed.) April 1953.

(Test plots in 140-year-old red pine-white pine eight years after partial cutting indicated that such stands should be reduced below 90 square feet of basal area to favor red pine reproduction. Otherwise white pine reproduction will predominate.)

Dickerman, M. B.

Attacking woody plant control problems through cooperative research. L.S. Misc. Report No. 21, pp. 58-60. (Processed.) 1953.

(Cooperation between public research agencies and industry has greatly advanced knowledge of woody plant control methods; there is room for more cooperative research in the Lake States.)

Eyre, F. H., and Zillgitt, W. M.

Partial cuttings in northern hardwoods of the Lake States (Twenty-year experimental results). U.S.D.A. Tech. Bul. No. 1076, 124 pp., illus. Sept. 1953.

(Based on 20-year experimental results, the possibilities of various cutting methods for handling northern hardwoods are discussed. The selection method of cutting is recommended for most mature stands with certain modifications to encourage yellow birch. Suggestions are given on how to mark northern hardwood stands under the selection system. Needs for and methods of making timber stand improvement operations in second-growth stands are discussed.)

Longwood, F. R.

Results of improvement cutting in second-growth northern hardwoods in Upper Michigan. L.S. Tech. Note, No. 386, 1 p. (Processed.) Jan. 1953.

(5-year records show it is practicable to make light improvement cuts in second-growth northern hardwoods in Upper Michigan.)

*_____

Grade recovery from sugar maple and yellow birch sawlog timber. Timber Prod. Bul. (Upper Mich. and Wis.) 123:20. June 1953.

(Remarkably uniform lumber recovery by grades for two years was shown by analysis of 400,000 board feet of sugar maple and yellow birch lumber on the Upper Peninsula Experimental Forest.)

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Some aspects of managing second-growth woodlands in Upper Michigan. L.S. Station Paper No. 29, 17 pp. illus. (Processed.) Dec. 1953.

(Annual cuts on 40 acres of 35 year old second growth northern hardwoods gave reasonable returns to the farmer-operator and improved the stand.)

Ralston, R. A.

Time required to prune red pine to various heights. L.S. Tech. Note, No. 391, 1 p. (Processed.) April 1953.

(The average labor cost to prune that portion of the bole between 12.5 and 17 feet was 70 to 80 percent greater than that for the lowest 12.5 feet.)

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Effect of pruning on the growth of red pine. L.S. Tech. Note, No. 405, 1 p. (Processed.) Oct. 1953.

(Up to 50 percent of the live crown length can be removed without retarding current annual height and diameter growth of young red pine; growth is retarded if 70 percent or more is removed.)

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Red pine suppressed for forty years responds to release. L.S. Tech. Note, No. 408, 2 pp. (Processed.) Oct. 1953.

(Red pine plantations severely suppressed by a dense hardwood overstory for as long as 40 years responded to release in northern lower Michigan.)

Roe, Eugene I.

Foliage spraying in chemical brush control. L.S. Misc. Report No. 21, pp. 17-21. (Processed.) 1953.

(Discusses forms of chemicals used; time, methods and rate of application; and where foliage spraying is recommended.)

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Research center increases studies of growing balsam pulp. Blackduck American (Ninth Annual Forest Fire Prevention Edition) 52 (20):3. April 23, 1953.

(Describes plans for increased study of different cutting methods for handling balsam fir stands in northern Minnesota.)

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Forest research center increases studies of growing balsam pulpwood. Timber Prod. Bul. (Duluth) 8(9):10-11. May 1953.

(See above.)

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Regeneration of balsam fir guaranteed by continuous reserve of small seedlings. L.S. Tech. Note, No. 404, 1 p. (Processed.) Oct. 1953.

(Mortality is high in advance reproduction of balsam fir following logging but enough usually remains to develop a dense stand.)

*_____

Resprouting of mountain maple after basal spraying with 2,4,5-T. Research Report, 10th Annual North Central Weed Control Conference, pp. 73-74. 1953.

(Small-scale tests indicate that mountain maple clumps can be killed and sprouting kept at a minimum by late fall basal spraying with a 2- to 4-percent solution of 2,4,5-T esters in No. 1 fuel oil.)

Rudolf, Paul O.

The place of chemical controls in forest management. L.S. Misc. Report No. 21, pp. 8-12. (Processed.) 1953.

(Chemical control appears to have a place in the Lake States for preparation of brushy sites for regeneration, and release of conifers from overtopping brush or low value hardwoods.)

_____

1952 forest tree seed crop fair in Lake States. L.S. Tech. Note No. 393, 2 pp. (Processed.) April 1953.

(Reports the estimated percentage of a full seed crop of the more important forest tree species in northern Minnesota, northern Wisconsin, central Upper Michigan, and Lower Michigan.)

Regeneration (Seed, nursery, planting, tree improvement)

McCulley, Robert D.

Gunning for loblolly pine cones. S.E. Forest Exp. Sta., Res. Notes, No. 40, 1 p. (Processed.) July 1953.

(Describes a method of obtaining cones from tall trees by shooting with a rifle equipped with telescopic sights.)

*_____

The Committee on Southern Forest Tree Improvement. L.S. Misc. Report No. 22, pp. 48-49. 1953.

(A brief account of the formation, purposes and activities of this committee.)

Ralston, R. A.

Some effects of spacing on jack pine development after 25 years. L.S. Tech. Note No. 388, 1 p. (Processed.) Jan. 1953.

(The trees planted at a 6x6-foot spacing have grown best as compared to those planted at 4x4- or 8x8-foot spacings.)

_____

Some effects of spacing on jack-pine development in lower Michigan after twenty-five years. Papers Mich. Acad. Sci., Arts & Letters 38:137-143. (Publ. 1953.)

(A more detailed report of the study discussed in Tech. Note No. 388.)

Roe, Eugene I.

Comparative height growth of native conifers in northeastern Minnesota. L.S. Tech. Note, No. 389, 1 p. (Processed.) Jan. 1953.
Also: Timber Prod. Bul. (Duluth) 8(6):6. Feb. 1953.

(10 years after planting average heights ranked as follows, from tallest to shortest: tamarack, jack pine, white pine, red pine, black spruce, and white spruce.)

Rudolf, Paul O., and Ralston, R. A.

Do age of mother trees and age of cones affect development of young jack pine? Jour. For. 51(2):121-124. Feb. 1953.

(Jack pine seed from young to overmature mother trees and from cones 1 to 5+ years old produced trees of no significant difference 8 to 12 years after planting in Lower Michigan.)

*_____

The Forest Genetics Steering Committee of the Inland Northwest Region. L.S. Misc. Report No. 22, pp. 49-50. (Processed.) 1953.

(A condensed account of the formation, purposes, and activities of this committee.)

*_____

Plows to precede a tree planting machine. U.S.D.A. Forest Service, Tree Planters' notes, No. 14, p. 10, illus. April 1953.

(Describes use of Minnesota pusher plow ahead of planting machines in northern Minnesota.)

*_____

Forest genetics work at the Lake States Forest Experiment Station. L.S. Misc. Report No. 22, pp. 1-10. (Processed.) 1953.

(A brief account of the research conducted by the Station since 1928 in testing seed sources, hybrids, and exotic species of forest trees.)

Stoeckeler, J. H.

Lupines as a nursery soil improvement crop. L.S. Tech. Note No. 395, 1 p. (Processed.) April 1953.

(Several lots of lupine seed obtained from Germany showed good promise on a sandy, rather acid soil in a northeastern Wisconsin nursery.)

*_____

Review of "Forstsamen-Gewinnung und forstpflanzen-Anzucht in den U.S.A. und in Deutschland (Tree Seed Collecting and Forest Plant Production in the U.S.A. and Germany)" by Ernst Pein, 218 pp., illus. M. & H. Schaper, Hanover, Germany. 1953. Unasylva 7(3):144. Sept. 1953.

*_____

Importance of seed source and the need of tree seed farms. L.S. Misc. Report No. 22, pp. 74-79. (Processed.) 1953.

(Explains the need for tree seed farms in the Lake States and how they might be established.)

## Mensuration (Growth, volume, yield, sampling)

Chase, C. D., and Gevorkiantz, S. R.

Volume in tops and limbs of sawlog trees. L.S. Tech. Note No. 390, 2 pp. (Processed.) January 1953.

(This table facilitates easy computation of the cord volume in sawlog trees above the last sawlog cut to a minimum 8 inch d.i.b.)

Guilkey, Paul C.

Jack pine growth rates in Minnesota. L.S. Tech. Note No. 394, 1 p. (Processed.) April 1953.

(Gives 10-year average diameter growth and annual gross growth percent as determined by Forest Survey in Central Pine District.)

## Forest Protection

### a. Fire

Mitchell, J. A.

Burning index ratings in fire control planning. L.S. Sta. Paper No. 28, 11 pp., illus. Nov. 1953.

(A case study showing how burning index ratings may be used to determine the normal fire load, its seasonal distribution, and the departure from normal to be expected.)

### b. Insects

*Beckwith, L. C.

Notes on the rearing of larch sawfly larvae. Proceedings Eighth Annual Meeting, North Central Branch, Ent. Soc. America. St. Louis, Mo. 1 p. (Processed.) March 1953.

(Description of techniques to determine average time and average amount of frass in each larval stadium.)

*_____

Collection of European elm bark beetles in Wisconsin. Jour. Econ. Ent. 46(5):913, October 1953.

(A report of the first official record in Wisconsin of an important vector of the Dutch elm disease.)

*_____, and H. J. MacAloney

Saratoga spittlebug surveys, Michigan and Wisconsin National Forests, 1953. BE&PQ., dittoed, 7 pp. October 1953.

(Appraisal surveys to determine needs for control by ranger districts - for budget estimates.)

*_____, and Underwood, N. B.

Swaine jack-pine sawfly in Wisconsin. Jour. Econ. Ent. 46(4):703. August 1953.

(Swaine jack-pine sawfly was reported for the first time in Wisconsin in 1952. Surveys indicated 400 acres infested by this species and the red-headed pine sawfly. Aerial spraying with DDT resulted in 96 percent control.)

Benjamin, D. M.

The jack-pine budworm in Michigan. L.S. Tech. Note No. 396, 1 p. (Processed.) April 1953.

(Mortality of infested jack pine on the Huron National Forest did not increase materially over that recorded in 1952. Average losses per acre were 3 percent in merchantable poles, 10 and 22 percent in 4-inch and 2-inch saplings, and 8 percent in reproduction.)

*_____

Pine sawfly. American Forests. 59(8):11,50-51, illus. August 1953.

(The red-headed, or LeConte's, sawfly is an important enemy of hard pines in the eastern United States. Host preference, life cycle, distribution, and control measures are discussed. The more important natural factors are listed.)

*_____, Batzer, H. O., and Ewan, H. G.

The lateral-terminal elongation growth rates of red pine as an index of Saratoga spittlebug injury. Jour. Forestry, 51(11):822-823. November 1953.

(Suitable criteria for measuring sub-clinical economic losses to red pine by the Saratoga spittlebug are discussed. Constant linear patterns of lateral-terminal elongation were established for non-injured open growing saplings for 3 seasons' growth. Drastic deterioration of coefficients of regression and correlation from fiducial patterns reflect the magnitude of adult feeding injury to red pine.)

*Drooz, A. T.

The wharf borer problem in Milwaukee, Wisconsin. Proceedings Eighth Annual Meeting, North Central Branch, Ent. Soc. America. St. Louis, Mo. 1 p. (Processed.) March 1953.

(Damage to pilings below buildings in downtown Milwaukee necessitated extensive repairs, costing more than $750,000.00, to prevent collapse of buildings.)

*_____

Larch sawfly investigations in Minnesota in 1952. Jour. Econ. Ent. 46(5):826-828. October 1953.

(A brief discussion of preliminary research findings in the larch sawfly investigation - presented at the 1952 Entomological Society of America Annual Meeting.)

*_____

Larch sawfly investigations in Minnesota in 1952. BE&PQ Special Report M-2, 30 pp. (Processed.) September 1953.

(A more detailed report of the larch sawfly investigation, discussing techniques used in carrying out studies of the life history and habits, and of the natural control factors.)

*_____, Beckwith, L. C., and Butcher, J. W.

The larch sawfly in the Lake States with special reference to Minnesota (1952 season - reconnaissance survey). BE&PQ. 7 pp. (Processed.) April 1953.

(An aerial survey to delineate the extent and severity of larch sawfly defoliation in Minnesota. Costs were about 9 cents per thousand acres of gross land area.)

*_____, with Hoffmann, C. H.

Effects of a C-47 airplane application of DDT on fish food organisms in two Pennsylvania watersheds. The American Midland Naturalist. 50(1):172-188. July 1953.

(The first operational study of the effects of aerially applied DDT on aquatic insects in the U. S. over a large area. Bottom insect populations were generally heavily depleted within 48 hours but increased to prespray numbers within 3 months.)

*Ewan, H. G.

The Saratoga spittlebug, Aphrophora saratogensis (Fitch), a study of gradients of feeding injury distribution on red pine, Pinus resinosa Ait., and notes on the diapausing egg. BE&PQ, Special Report M-1, 36 pp. (Processed.) April 1953.

(A research problem to determine the distribution of adult spittlebug feeding punctures and resulting twig injury with a view toward establishing a sampling site which would give comparable estimates of the insect population.)

*_____

A sawfly injurious to shortleaf pine in Indiana. BE&PQ Special Report M-3, 6 pp. (Processed.) September 1953.

(Preliminary biological studies of an undescribed species of pine sawfly affecting shortleaf pine.)

*Forest Insect Laboratory.

The forest insect situation in the Lake States in 1952. BE&PQ, 6 pp. (Processed.) April 1953.

(A coordinated report compiled by the staff of the Milwaukee forest insect laboratory from survey information collected by federal, state, and private agencies.)

c. Diseases

*Anderson, Ralph L. and Kaufert, Frank H.

The control of dwarf mistletoe on black spruce. Minn. Forestry Notes No. 13, 2 pp. (Processed.) illus. Jan. 15, 1953.

(Brief account of dwarf mistletoe on black spruce in northern Minnesota and possibilities for its control.)

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Hypoxylon canker of aspen in the Lake States. L.S. Tech. Note No. 400, 1 p. (Processed.) July 1953.

(Gives tentative recommendations for the management of aspen to minimize damage from Hypoxylon canker.)

d. Wildlife

*Aldous, Shaler E.

Deer browse clipping study in the Lake States Region, Jour. Wildl. Mgt., 16:(4)401-409., illus. Oct. 1952.

(Response of northern white-cedar, mountain maple, white birch, beaked hazelnut, mountain-ash, red osier dogwood, pin cherry, willow and red-berried elder to different degrees of artificial browsing.)

Krefting, Laurits W.

Deer damage to a jack pine plantation in Michigan. L.S. Tech. Note No. 387, 1 p. (Processed.) Jan. 1953. Also: Timber Prod. Bul. (Duluth) 8(6):8. Feb. 1953.

(Exclosure study shows that protected seedlings suffered no mortality while unprotected seedlings suffered from 23 to 31 percent in mortality and had a lower height growth.)

*_____

Effect of cutting mountain maple on the production of deer browse. Minn. Forestry Notes No. 21. 2 pp. (Processed.) Sept. 15, 1953.

(Clumps of mountain maple on several 2-acre test plots were cut at ground level to induce sprouting (1937). A remeasurement of 50 test clumps has shown the amount of deer browse remained high sixteen years after cutting (1952).)

_____, and Stoeckeler, J. H.

Effect of simulated snowshoe hare and deer damage on planted conifers in the Lake States. Jour. Wildl. Mgt., 17(4):487-494. Oct. 1953.

(Sensitivity to clipping which simulates snowshoe hare and deer damage was in this order, the most sensitive first: red pine, jack pine, white pine, and white spruce.)

*Martin, F. R., and Krefting, Laurits W.

The Necedah Refuge deer irruption. Jour. Wildl. Mgt., 17(2):166-176, illus. April 1953.

(Deer of this central Wisconsin area increased from 6 per square mile in 1936 to 80 per square mile in 1946. Hunting (1945-1950) reduced the herd to a level the range could support. Had hunting begun earlier (1942) about twice as many deer could have been taken and the range would have been saved. Fawn production doubled after one year of gun hunting. The causes of the irruption are listed.)

Krefting, Laurits W.

Snowshoe hare damage to a jack pine plantation in Minnesota. L.S. Tech. Note No. 402, 1 p. (Processed.) July 1953.

(Exclosure study shows that so far the greatest damage to seedlings has been loss in height. Seedlings protected from hares produced two and a half times more growth per seedling than those accessible to hares in the deerproof section of the exclosure and in the control plot.)

## Forest Survey

Chase, C. D.

Timber Resources, Muskegon-Saginaw Section, Lower Peninsula, Michigan. Michigan Conservation Dept. in cooperation with L.S.F.E.S. and others. 38 pp. + appendix. (Processed.) illus. 1953.

(This report presents the forest areas, timber volumes, growth and allowable cut for 11 counties in the central part of the Lower Peninsula, Michigan.)

Cunningham, R. N., and Findell, Virgil.

Resurgence of Tamarack in Minnesota. L.S. Tech. Note No. 397, 2 pp. (Processed.) April 1953.

(Shows striking improvement in size and density of stands indicated by recent Forest Surveys.)

Horn, A. G.

1951 Lake States Pulpwood Production reaches all time high. L.S. Tech. Note No. 398, 2 pp. (Processed.) July 1953.

(Shows production by species in Minnesota, Wisconsin and Michigan - also imports from Canada and western states and movement between states in the region. Sixth of an annual series.)

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1952 Lake States pulpwood production continues at high level. L.S. Tech. Note No. 399, 2 pp. (Processed.) July 1953.

(Seventh of an annual series - see preceding page.)

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Veneer log production declines in Lake States. L.S. Tech. Note No. 403, 2 pp. (Processed.) Oct. 1953.

(Gives record of veneer logs cut and imported into the three Lake States.)

Johnson, Howard, Horn A. G., Guilkey, P. C.

Forest Resources of Wadena County, Minnesota. Iron Range Res. & Rehab. 58 pp. illus. November 1953.

(One of series of county reports summarizing and analyzing results of cooperative Forest Survey. Gives forest areas, timber volumes, growth, drain, and allowable cut by species and kinds of timber; analyzes conditions by land ownership groups.)

_____, _____, _____.

Forest Resources of Hubbard County, Minnesota. Iron Range Res. & Rehab. 63 pp. illus. December 1953.

(Another in county series.)

Ralston, Robert A.

Basal area as a guide in estimating logging costs. Jour. For. 51(12):886-890. illus. Dec. 1953.

(Examples using adapted data from 10 different logging cost studies show that one square foot of basal area can be harvested by hand operations at about a constant rate regardless of size-class distribution of the trees harvested.)

## General

*Cunningham, R. N.

Credit where credit is due. Jour. For. 51(1):36. Jan. 1953.

(How should proper credit be given for preparation of scientific articles?)

Varney, Richard M., Cunningham, R. N., and Others.

Ryukyu Islands Forest Situation. Special Bul. #2. U. S. Civil Administration of the Ryukyu Islands. 123 pp. illus.

Dickerman, M. B.

Forest research in the Lake States. Connecticut Caliper, University of Conn. 33 pp. May 1953.

(A current summary of the organization and operation of the Lake States Forest Exp. Sta. research program.)

*Lake States Forest Experiment Station.

The work area and program of the Headwaters Forest Research Center. L.S. Misc. Report No. 24. 17 pp. illus. June 1953.

(A brief, illustrated description of the work area, the forest management problems, and the research program under way at the Headwaters Forest Research Center in northern Minnesota.)

*Kaufert, F. H., Neetzel, J. R., Hossfeld, R. L., and Rees, L. W.

A small vacuum treating plant. Minn. Forestry Note No. 12, 2 pp. illus. (Processed.) Dec. 15, 1952. Also: Jour. For. 51(5): 366-367. May 1953.

(Describes a small vacuum treating plant which can be built for about $6000.)

## Forest Economics

Arbogast, Carl, Jr.

Lumber and log grade yields from second-growth northern hardwoods. Jour. Forest Products Research Soc. 3(1):25-27, 79. Illus. Feb. 1953.

(Timber from improvement cuts in second-growth northern hardwood stands in northern Wisconsin yielded lumber of enough value to make commercial operations practicable; maple and birch cull logs yielded valuable lumber but submerchantable logs did not; and the Forest Products Laboratory log grade rules and recovery tables applied satisfactorily to this timber.)

Dickerman, M. B.

Status and trends of forest resources and industry, pp. 53-60 in "Research in the economics of forestry" by William A. Duerr & Henry J. Vaux. Charles Lathrop Pack Forestry Foundation, Washington, D.C. 1953.

(A comprehensive discussion of forest-economic studies which lead to a broad understanding of the whole forest economy of a particular area. Discusses how such studies are made, methods of obtaining data and analytical procedure.)

Blair, Roland W., and Ralston, Robert A.

Comparison of man hours required for thinning and clear cutting pole-size aspen. L.S. Tech. Note No. 407, 1 p. (Processed.) Oct. 1953.

(Logging time (including felling, bucking, skidding, loading, road-building, and delays) per cord averaged as follows in man hours: low thinning, 4.0; crown thinning, 3.6; and clear cutting, 3.0.)

Stump, William G., Ralston, Robert A., and Arend, John L.

Log grading starts in the woods. L.S. Tech. Note No. 406, 1 p. (Processed.) Oct. 1953. Also: Timber Prod. Bul. (Upper Mich. and Wis.) 127:5. Oct. 1953.

(Study of a commercial white oak logging operation in southern Michigan revealed that proper application of standard log grading rules by cutters in the woods would have given a 12-percent increase in volume of grade No. 1 logs.)

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*Kaufert, F. H., Neetzel, J. R., Hossfeld, R. L., and Rees, L. W.

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(Describes a small vacuum treating plant which can be built for about $6000.)

*_____, _____, _____, and _____.

Construction of a small low-cost vacuum treating plant. Jour. Forest Prod. Res. Soc. 3(1):31-33, 79-80. illus. Feb. 1953.

(Describes and gives plans for constructing a small low-cost vacuum treating plant.)

Neetzel, John R.

Building better farm fences. Univ. of Minn., Agric. Ext. Service, Ext. Bul. No. 272, 11 pp. illus. March 1953.

(Describes and illustrates methods and materials for building strong and durable fences.)

Kaufert, Frank H., Neetzel, John R., and Hossfeld, Ralph.

This new plant applies wood preservative at relatively low cost. Minn. Farm & Home Sci. 10(3):10-11, illus. May 1953.

(Describes small low-cost vacuum treating plant.)

*Roe, Eugene I.

1952 winter meeting Upper Mississippi Valley Section. Jour. For. 51(5):378-379. May 1953.

(Brief report of S.A.F. Section meeting proceedings.)